US EPA – APPROVED

TOTAL MAXIMUM DAILY LOAD (TMDL)

FOR THE

RIO CHAMA WATERSHED

[ABIQUIU RESERVOIR TO HEADWATERS]

AUGUST 16, 2011

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COVER PHOTO*: Rio Chama above Abiquiu Reservoir, May 1999.*

LIST OF ABBREVIATIONS

4Q3	4-Day, 3-year low-flow frequency
BMP	Best management practices
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CGP	Construction general storm water permit
CWA	Clean Water Act
^oC	Degrees Celcius
^oF	Degrees Farenheit
HUC	Hydrologic unit code
$j/m^2/s$	Joules per square meter per second
km^2	Square kilometers
LA	Load allocation
lbs/day	Pounds per day
mgd	Million gallons per day
mg/L	Milligrams per Liter
mi^2	Square miles
mL	Milliliters
MOS	Margin of safety
MOU	Memorandum of Understanding
MS4	Municipal separate storm sewer system
MSGP	Multi-sector general storm water permit
NM	New Mexico
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint source
QAPP	Quality Assurance Project Plan
RFP	Request for proposal
SEE	Standard Error of the Estimate
SSTEMP	Stream Segment Temperature Model
SWPPP	Storm water pollution prevention plan
SWQB	Surface Water Quality Bureau
TMDL	Total Maximum Daily Load
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USGS	U.S. Geological Survey
WLA	Waste load allocation
WQCC	Water Quality Control Commission
WQS	Water quality standards (NMAC 20.6.4 as amended through August 31, 2007)
WBP	Watershed-based plan
WWTP	Wastewater treatment plant

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EXECUTIVE SUMMARY

Section 303(d) of the Federal Clean Water Act requires states to develop Total Maximum Daily Load (TMDL) management plans for water bodies determined to be water quality limited. A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint source and background conditions. TMDLs also include a Margin of Safety (MOS).

The Surface Water Quality Bureau (SWQB) conducted a water quality survey of the Rio Chama Basin of northcentral New Mexico in 2007. Water quality monitoring stations were located within the watershed to evaluate the impact of tributary streams and ambient water quality conditions. As a result of assessing data generated during this monitoring effort, impairment determinations of New Mexico water quality standards include the following:

- BACTERIA (*E. coli*) in Rio Capulin (Rio Gallina to headwaters), Rio Chama (El Vado Reservoir to Rio Brazos), Rio Chama (Little Willow Creek to CO border), Rio Chama (Rio Brazos to Little Willow Creek), Rio Chamita (Rio Chama to CO border), and Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96);
- PLANT NUTRIENTS in Rio Chama (El Vado Reservoir to Rio Brazos), Rio Chama (Rio Brazos to Little Willow Creek), Rio Chamita (Rio Chama to CO border), and Rio Tusas (Rio Vallecitos to headwaters);
- SPECIFIC CONDUCTANCE in Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters) and;
- TEMPERATURE in Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters), Rio Chama (El Vado Reservoir to Rio Brazos), Rio Chama (Little Willow Creek to CO border), and Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96).

SWQB data collections documented continued impairments of the New Mexico WQS. These are "old" impairment listings that already resulted in a TMDL but continue to be impaired based on the 2007 data and assessments include:

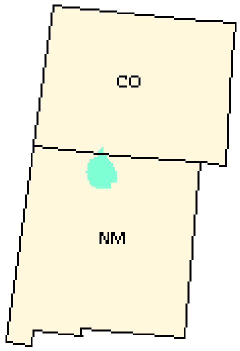
- BACTERIA (*E. coli*) on Rio Chamita (Rio Chama to CO border). A fecal coliform TMDL was previously developed for this AU and it is now impaired for *E.coli.*
- TEMPERATURE on Rio Chama (Rio Brazos to Little Willow Creek) and Rio Chamita (Rio Chama to CO border).

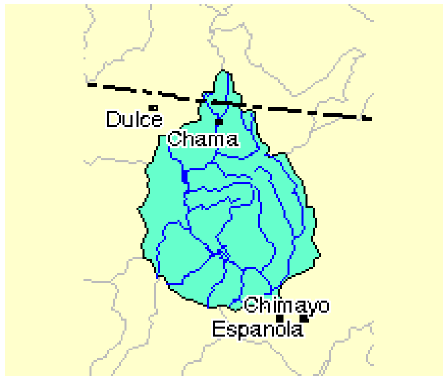
This TMDL document addresses the above noted impairments as summarized in the tables below. The data used to develop this TMDL were collected during the 2007 Rio Chama survey with follow-up collections in 2010. The 2007 study identified other potential water quality impairments which are not addressed in this document. Additional data needs for verification of those impairments are being identified and data collection will follow. If these impairments are verified, subsequent TMDLs will be prepared in a separate TMDL document.

The SWQB's Monitoring and Assessment Section will collect water quality data during the next rotational cycle. The next scheduled monitoring date for the Rio Chama Watershed is 2012 at which time TMDL targets will be re-examined and potentially revised as this document is considered to be an evolving management plan. In the event that new data indicate that the targets used in this analysis are not appropriate and/or if new standards are adopted, the load capacity will be adjusted accordingly. When water quality standards have been achieved, the reach will be moved to the appropriate category in the Integrated Report.

The SWQB's Watershed Protection Section will continue to work with watershed groups to develop Watershed-Based Plans to implement strategies that attempt to correct the water quality impairments detailed in this document. Implementation of items detailed in the Watershed-Based Plans will be done with participation of all interested and affected parties.

TOTAL MAXIMUM DAILY LOAD FOR
CANJILON CREEK (PERENNIAL PORTIONS ABIQUIU RSRV TO HEADWATERS)

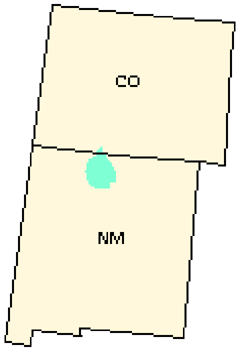


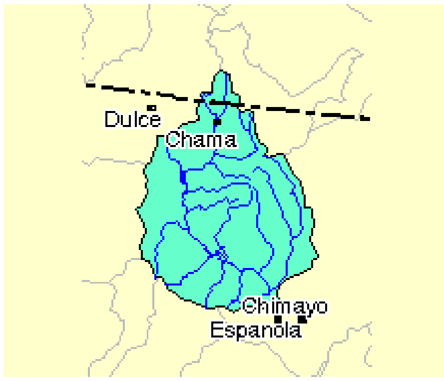


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_030, formerly known as NM-URG2-10900
Segment Length	30.63 miles
Parameters of Concern	Specific conductance, temperature
Uses Affected	High Quality Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	166 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	47% forest, 35% grassland, 16% shrubland, and <1% pasture
Probable Sources*	Agriculture, flow alterations from water diversions, loss of riparian habitat, streambank modifications/destabilization, unknown.*
Land Management	77% USFS, 22% private, and <1% State and BLM
IR Category	5/5B
Priority Ranking	High
TMDL for: Specific conductance Temperature	**WLA + LA + MOS = TMDL** **0 + 922 + 231 = 1153 lbs/day** **0 + 58.14 + 6.46 = 64.60 j/m²/s/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 5.7 and 6.8.*

TOTAL MAXIMUM DAILY LOAD FOR RIO CAPULIN (RIO GALLINA TO HEADWATERS)

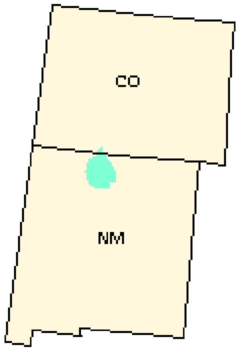


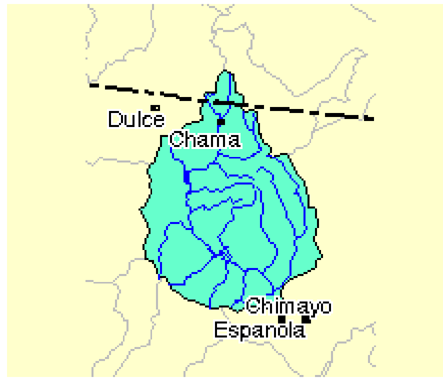


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_041, formerly known as NM-URG2-20210
Segment Length	12.1 miles
Parameters of Concern	*E.coli*
Uses Affected	Secondary Contact
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	32 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	79% forest, 11% pasture, and 10% grassland
Probable Sources*	Unknown*
Land Management	84% USFS and 16% private
IR Category	5/5A
Priority Ranking	High
TMDL for: *E.coli*	**WLA + LA + MOS = TMDL** **0 + 1.62×10^9 + 1.80×10^8 = 1.80×10^9 cfu/day**

**No additional Probable Sources available from the 2007 water quality survey.*

TOTAL MAXIMUM DAILY LOAD FOR
RIO CHAMA (EL VADO RESERVOIR TO RIO BRAZOS)

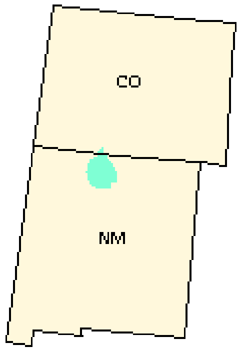


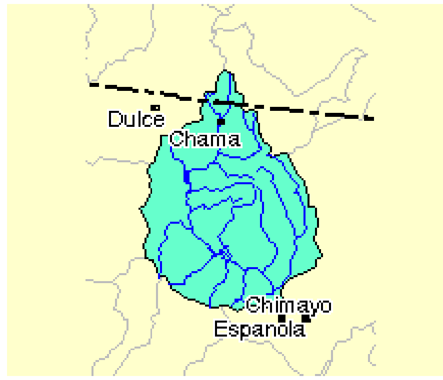


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_000
Segment Length	14.95 miles
Parameters of Concern	*E.coli*, nutrients, temperature
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	482 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	53% forest, 22% grassland, 20% shrubland, 4% pasture, and <1% low intensity residential, crops, and barren soil
Probable Sources*	Unknown*
Land Management	54% USFS, 31% Pueblo, 13% private, 1% State Game and Fish, and <1% NM State Parks
IR Category	5/5C
Priority Ranking	High
TMDL for:	**WLA + LA + MOS = TMDL**
E.coli	**1.35×10^{10} + 3.54×10^{10} + 5.43×10^{9} = 5.43×10^{10} cfu/day**
Temperature	**0** + 117.04 + 13.00 = 130.04 j/m^2/s/day**
Plant Nutrients	
Total Phosphorus	**1.65 + 4.34 + 0.666 = 6.66 lbs/day**
Total Nitrogen	**5.88 + 15.5 + 2.38 = 23.8 lbs/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 3.8, 4.13-4.14, and 6.8.*

TOTAL MAXIMUM DAILY LOAD FOR
RIO CHAMA (LITTLE WILLOW CREEK TO CO BORDER)

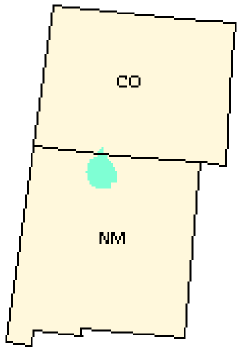


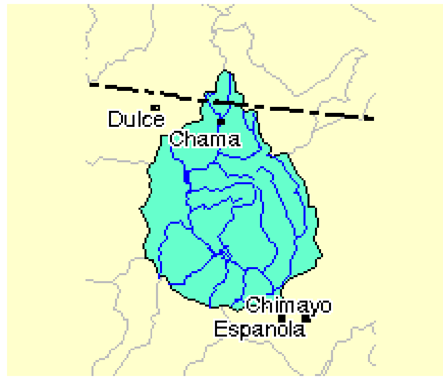


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_002
Segment Length	9.92 miles
Parameters of Concern	*E.coli*, temperature
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	102 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	63% Forest; 19% shrubland, 16% grassland, 1% barren, 1% pasture
Probable Sources*	Unknown*
Land Management	78% Forest Service; 19% Private; 2% Native Lands; 1% NM Game and Fish
IR Category	5/5C
Priority Ranking	High
TMDL for: *E.coli* Temperature	**WLA + LA + MOS = TMDL** **0 + 5.05×10^{10} + 5.61×10^{9} = 5.61×10^{10} cfu/day** **0 + 103.66 + 11.52 = 115.18 $j/m^2/s/day$**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 3.8 and 6.8.*

TOTAL MAXIMUM DAILY LOAD FOR
RIO CHAMA (RIO BRAZOS TO LITTLE WILLOW CREEK)

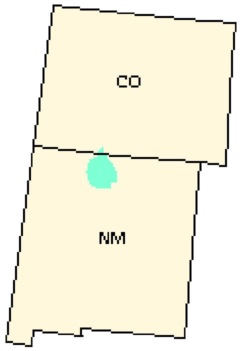


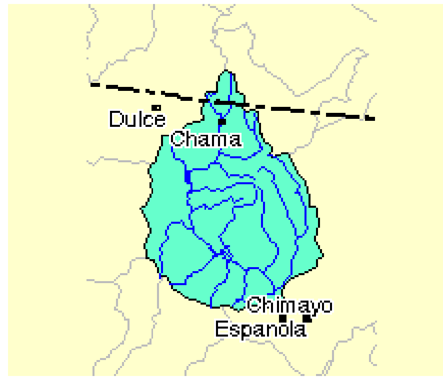


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_001
Segment Length	11.72 miles
Parameters of Concern	*E.coli*, nutrients, temperature,
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	219 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	58% Forest; 26% shrubland, 14% grassland, 3% pasture
Probable Sources *	Flow alterations from water diversions, loss of riparian habitat, rangeland grazing, streambank modifications/destabilizations, unknown .*
Land Management	55% USFS, 31% Native Lands, 14% Private, <1% NM Game and Fish
IR Category	5/5C
Priority Ranking	High
TMDL for:	**WLA + LA + MOS = TMDL**
E.coli	**0 + 3.44×10^{10} + 3.82×10^{9} = 3.82×10^{10} cfu/day**
Plant Nutrients:	
Total Phosphorus	**0 + 4.19 + 0.465 = 4.65 lbs/day**
Total Nitrogen	**0 + 15.0 + 1.66 = 16.6 lbs/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 3.8 and 4.13-4.14.*

TOTAL MAXIMUM DAILY LOAD FOR RIO CHAMITA (RIO CHAMA TO CO BORDER)

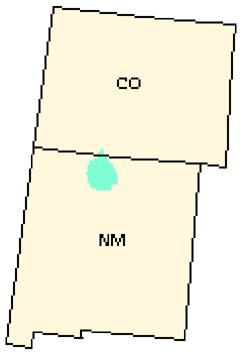


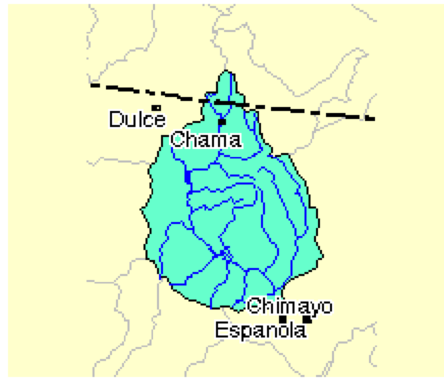


New Mexico Standards Segment	20.6.4.119
Waterbody Identifier	NM-2116.A_110, formerly known as NM-URG2-30500
Segment Length	13.68 miles
Parameters of Concern	*E.coli*, nutrients
Uses Affected	Secondary Contact, High Quality Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	44 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	49% forest, 40% shrubland, 10% grassland, <1% pasture, and <1% low intensity residential
Probable Sources*	Flow alterations from water diversions, loss of riparian habitat, municipal point source discharges, natural sources, rangeland grazing, streambank modifications/destabilization, unknown.*
Land Management	95% private and 5% NM Game and Fish
IR Category	5/5A
Priority Ranking	High
TMDL for:	**WLA + LA + MOS = TMDL**
E. coli	**1.43×10^9 + 3.32×10^9 + 5.28×10^8 = 5.28×10^9 cfu/day**
Plant Nutrients	
Total Phosphorus	**0.250 + 0.808 + 0.118 = 1.18 lbs/day**
Total Nitrogen	**2.50 + 8.08 + 1.18 = 11.8 lbs/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 3.8 and 4.13-4.14.*

TOTAL MAXIMUM DAILY LOAD FOR
RIO PUERCO DE CHAMA (ABIQUIU RESERVOIR TO HWY 96)

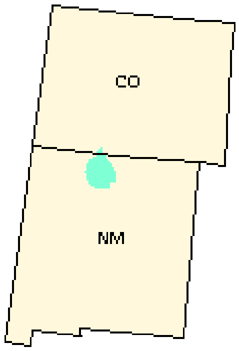


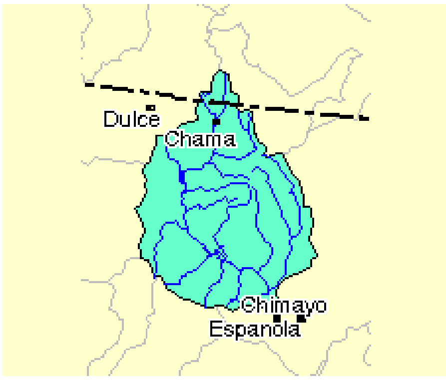


New Mexico Standards Segment	20.6.4.118
Waterbody Identifier	NM-2115_20, formerly known as NM-URG2-11100
Segment Length	8.81 miles
Parameters of Concern	Aluminum, *E. coli*, temperature
Uses Affected	Secondary Contact, Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	202 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	68% forest, 21% grassland, 10% shrubland, <1% orchards/vineyards, and <1% pasture
Probable Sources*	Loss of riparian habitat, rangeland grazing, unknown*
Land Management	91% USFS, 5% VCNP, 4% private, <1% State, and <1% BLM
IR Category	5/5C
Priority Ranking	High
TMDL for: *E. coli* Temperature	**WLA + LA + MOS = TMDL** **0 + 3.55×10^9 + 3.94×10^8 = 3.94×10^9 cfu/day** **0 + 211.26 + 23.47 = 234.73 j/m^2/s/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 3.8 and 6.8.*

TOTAL MAXIMUM DAILY LOAD FOR RIO TUSAS (RIO VALLECITOS TO HEADWATERS)





New Mexico Standards Segment	20.6.4.116
Waterbody Identifier	NM-2113_30, formerly known as NM-URG2-10300
Segment Length	12.2 miles
Parameters of Concern	Nutrients
Uses Affected	Coldwater Aquatic Life
Geographic Location	Rio Chama USGS Hydrologic Unit Code 13020102
Scope/size of Watershed	198 square miles
Land Type	Southern Rockies (Ecoregion 21)
Land Use/Cover	56% forest, 24% shrubland, 20% grassland, and <1% pasture
Probable Sources*	Unknown*
Land Management	99% USFS and <1% private
IR Category	5/5A
Priority Ranking	High
TMDL for:	**WLA + LA + MOS = TMDL**
Plant Nutrients:	
Total Phosphorus	**0 + 0.112 + 0.012 = 0.124 lbs/day**
Total Nitrogen	**0 + 1.40 + 0.155 = 1.55 lbs/day**

** additional Probable Sources noted during the 2007 water quality survey are listed in Tables 4.13-4.14.*

1.0 INTRODUCTION

Under Section 303 of the federal Clean Water Act (CWA), states establish water quality standards, which are submitted and subject to the approval of the U.S. Environmental Protection Agency (USEPA). Under Section 303(d)(1) of the CWA, states are required to develop a list of waters within a state that are impaired and establish a total maximum daily load (TMDL) for each pollutant. A TMDL is defined as "*a written plan and analysis established to ensure that a waterbody will attain and maintain water quality standard including consideration of existing pollutant loads and reasonably foreseeable increases in pollutant loads*" (USEPA 1999). A TMDL documents the amount of a pollutant a waterbody can assimilate without violating a state's water quality standards. It also allocates that load capacity to known point sources and nonpoint sources at a given flow. TMDLs are defined in 40 Code of Federal Regulations (CFR) Part 130 as the sum of the individual Waste Load Allocations (WLAs) for point sources and Load Allocations (LAs) for nonpoint sources and natural background conditions." TMDLs also include a margin of safety (MOS). This document provides TMDLs for assessment units within the Rio Chama watershed that have been determined to be impaired based on a comparison of measured concentrations and conditions with numeric water quality criteria or with numeric translators for narrative standards.

This document is divided into several sections. Section 2.0 provides background information on the location and history of the Rio Chama Watershed, provides applicable water quality standards for the assessment units addressed in this document, and briefly discusses the intensive water quality survey that was conducted in the Rio Chama Watershed in 2007. Section 3.0 provides *E. coli* TMDLs, Section 4.0 contains nutrient TMDLs, Section 5.0 contains a specific conductance TMDL and Section 6.0 details temperature TMDLs. Pursuant to CWA Section 106(e)(1), Section 7.0 provides a monitoring plan in which methods, systems, and procedures for data collection and analysis are discussed. Section 8.0 discusses implementation of TMDLs (phase two) and the relationship between TMDLs and Watershed-Based Plans (WBPs). Section 9.0 discusses assurance, Section 10.0 public participation in the TMDL process, and Section 11.0 provides references.

2.0 RIO CHAMA WATERSHED CHARACTERISTICS

The Rio Chama Basin was sampled by the Surface Water Quality Bureau (SWQB) from April to November 2007 (NMED/SWQB, 2011). Surface water quality monitoring stations were selected to characterize water quality of perennial stream reaches of the Rio Chama and its tributaries. Sites were also selected throughout the Rio Chama watershed to collect additional data for assessment units needing additional data for TMDL development. Numerous TMDLs exist for waterbodies in this watershed, but additional data was needed to complete TMDLs on the remainder of the waterbodies. In 2010, additional sites were also selected throughout the Rio Chama watershed for additional data for TMDL development. Information regarding previous sampling efforts by SWQB in the Rio Chama watershed is detailed in the Water Quality Survey Summary for the Lower Rio Chama Watershed (NMED/SWQB, 1999a) available on the SWQB website. A number of water quality impairments identified during this survey are addressed in this document.

2.1 Location Description

The Rio Chama Watershed (US Geological Survey [USGS] Hydrologic Unit Codes [HUC] 13020102) is located in northcentral New Mexico (NM). The entire Rio Chama watershed from El Vado Reservoir to the Colorado border ranges from 2,103 to 3,511 meters (6,900 to 11,518 feet) in elevation and covers approximately 1,248 km^2 (482 mi^2).

The upper Rio Chama watershed is located in Omernik Level III Ecoregion 21 (Southern Rockies). As presented in **Figure 2.1**, land use is 53% forest, 22% grassland, 20% shrubland, 4% pasture, and <1% low intensity residential, crops, and barren soil. Historic and current land uses in the watershed include farming, ranching, recreation, and municipal related activities. Much of the land ownership adjacent to the river is private or US Forest Service (USFS) with the exceptions of Jicarilla Apache lands on the western portion of the watershed (**Figure 2.2**).

Numerous species within this watershed are listed as either threatened or endangered by both State and Federal agencies. Federally listed endangered and threatened species of particular interest due to reliance on aquatic and riparian habitat in the watershed include the Rio Grande Silvery Minnow, Boreal Toad, Jemez Mountains Salamander, American Peregrine Falcon, Boreal Owl, and Southwestern Willow Flycatcher.
(http://nhnm.unm.edu/query_bcd/bcd_watershed_query.php5).

Figure 2.1 Land Use and 2007 Sampling Stations in the Rio Chama Watershed. See Table 2.1 for station information.

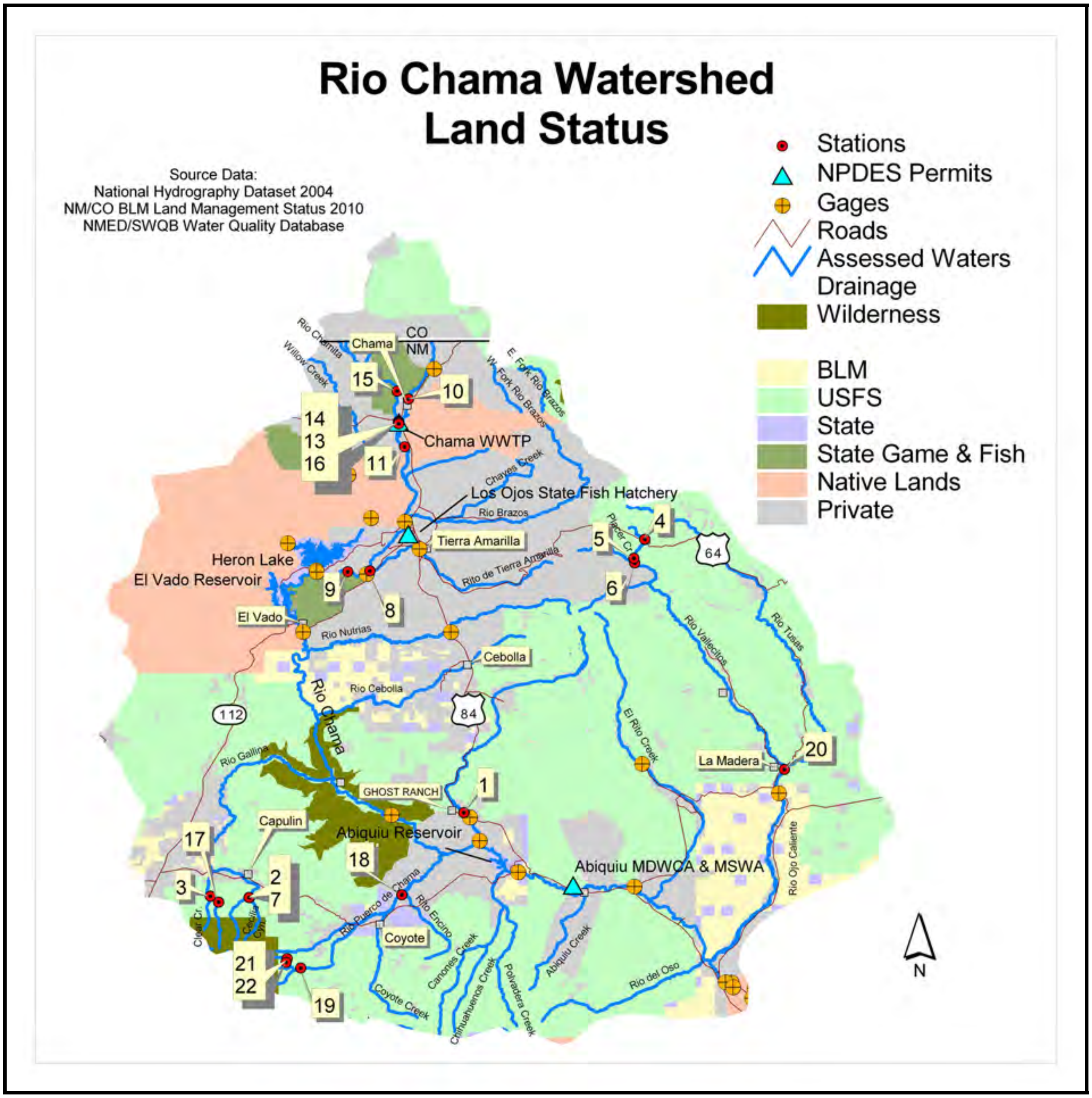


Figure 2.2 Land Management and 2007 Sampling Stations in the Rio Chama Watershed

2.2 Geology and Land Use

Ten tributary watersheds to the Rio Chama were sampled during the 2007 survey. Historic and current land uses in these watersheds include farming, ranching, forestry, and residential/commercial related activities. Some of the land ownership is private including a portion of the Jicarilla Apache reservation, but the United States Forest Service (USFS), State of New Mexico, and Bureau of Land Management (BLM) also own and manage tracts of public lands in the sub-watersheds. These watersheds are located in Omernick Level III ecoregions 21 (Southern Rockies) and 22 (Arizona/New Mexico Plateau). The elevation range for the various watersheds in the survey spanned from 1,882 to 3,176 meters (6,175 to 10,420 feet above sea level).

The predominant lithologies within the Rio Chama are sandstones, shales, mudstones, and claystones of the Chinle, San Rafael, and Mesaverde Groups as well as the Animas, Nacimiento, Ojo Alamo, and San Jose Formations (**Figure 2.3**). In addition, the upper portion of the watershed consists partially of Tertiary felsic volcanic rocks of Bandelier Tuff and alluvium of the Santa Fe Group. Flint from these formations was mined by pre-Columbian Native Americans. The Cumbres Mountains near Chama are composed of Precambrian granite and more Tertiary volcanic rocks. (Chronic, 1987)

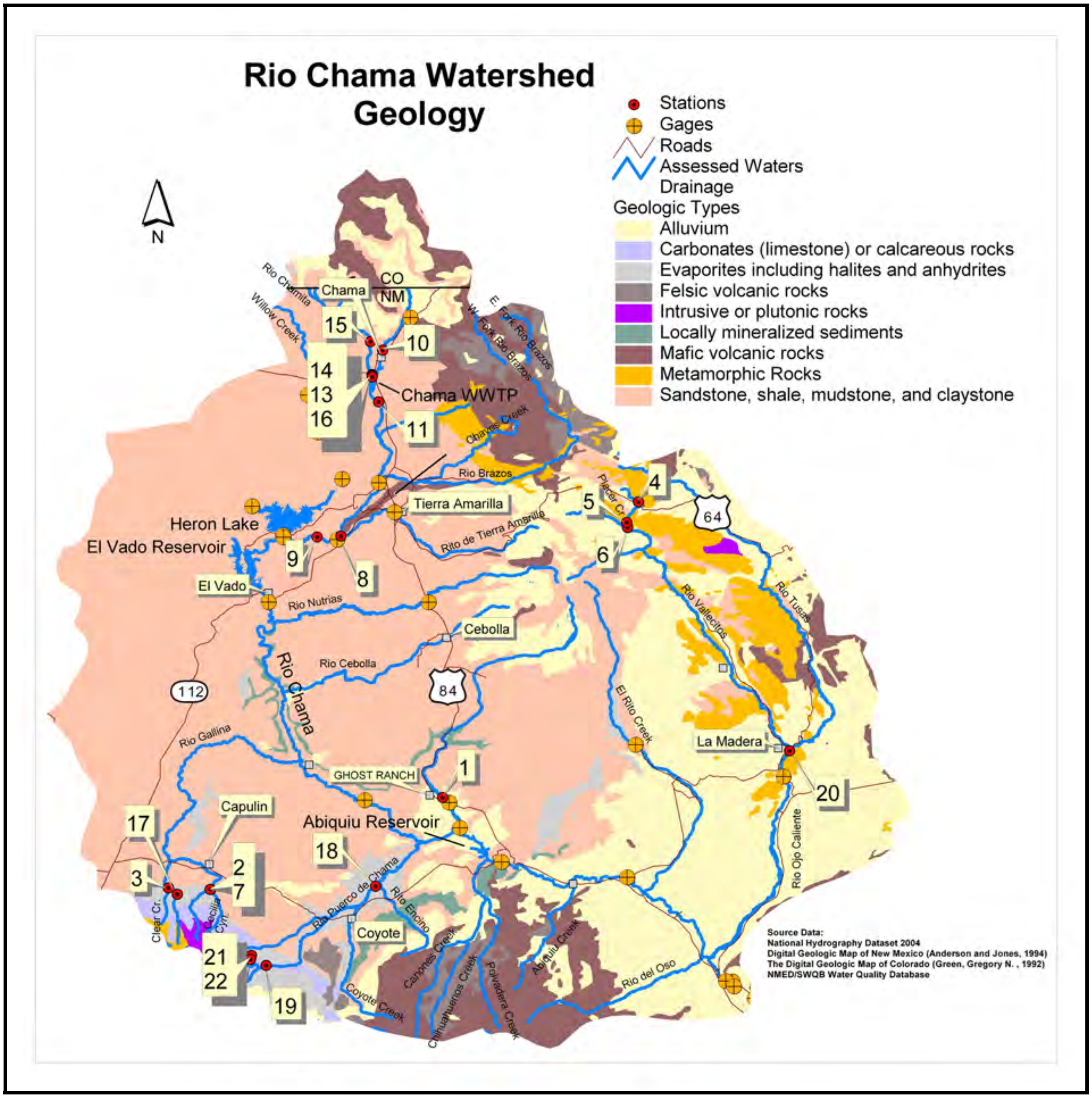


Figure 2.3 Geologic Map of the Rio Chama Watershed and 2007 Sampling Stations

2.3 Water Quality Standards and Designated Uses

Water quality standards (WQS) for all assessment units in this document are set forth in sections, 206.4.116, 20.6.4.118 and 20.6.4.119 of the *Standards for Interstate and Intrastate Surface Water s,* 20.6.4 New Mexico Administrative Code, as amended through August 1, 2007 (NMAC 2007). These standards have been approved by EPA for Clean Water Act purposes.

20.6.4.116 RIO GRANDE BASIN - The Rio Chama from its mouth on the Rio Grande upstream to Abiquiu reservoir, perennial reaches of the Rio Tusas, perennial reaches of the Rio Ojo Caliente, perennial reaches of Abiquiu creek and perennial reaches of El Rito creek below the town of El Rito.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, coldwater aquatic life, warmwater aquatic life and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 31°C (87.8°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 548 cfu/100 mL or less; single sample 2507 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.116 NMAC - Rp 20 NMAC 6.1.2113, 10-12-00; A, 05-23-05]

20.6.4.118 RIO GRANDE BASIN - The Rio Chama from the headwaters of Abiquiu reservoir upstream to El Vado reservoir and perennial reaches of the Rio Gallina and Rio Puerco de Chama north of state highway 96.

A. Designated Uses: irrigation, livestock watering, wildlife habitat, coldwater aquatic life, warmwater aquatic life and secondary contact.

B. Criteria:

(1) In any single sample: pH within the range of 6.6 to 8.8 and temperature 26°C (78.8°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.118 NMAC - Rp 20 NMAC 6.1.2115, 10-12-00; A, 05-23-05]

20.6.4.119 RIO GRANDE BASIN - All perennial reaches of tributaries to the Rio Chama above Abiquiu dam except the Rio Gallina and Rio Puerco de Chama north of state highway 96 and the main stem of the Rio Chama from the headwaters of El Vado reservoir upstream to the New Mexico-Colorado line.

A. Designated Uses: domestic water supply, fish culture, high quality coldwater aquatic life, irrigation, livestock watering, wildlife habitat and secondary contact.

B. Criteria:

(1) In any single sample: specific conductance 500 µmhos/cm or less (1,000 µmhos or less for Coyote creek), pH within the range of 6.6 to 8.8 and temperature 20°C (68°F) or less. The use-specific numeric criteria set forth in 20.6.4.900 NMAC are applicable to the designated uses listed above in Subsection A of this section.

(2) The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less (see Subsection B of 20.6.4.14 NMAC).

[20.6.4.119 NMAC - Rp 20 NMAC 6.1.2116, 10-12-00; A, 05-23-05]

The numeric criteria identified in these sections are used for assessing waters for use attainability. The referenced Section 20.6.4.900 NMAC provides a list of water chemistry analytes for which SWQB tests and identifies numeric criteria for specific designated uses. In addition, waters are assessed against the narrative criteria identified in Section 20.6.4.13 NMAC, including bottom sediments and suspended or settleable solids, plant nutrients, and turbidity. The individual water quality criteria or narrative standards are detailed for each parameter in the chapters that follow.

SWQB proposed revisions to the WQS during the Triennial Review in December 2009. The new WQS are effective for State purposes as of December 1, 2010. The US EPA has not yet acted on the new WQCC-approved WQS; the new WQS do not apply for CWA purposes until approved by the US EPA. None of the WQS revisions would affect the TMDLs in this document .However, the details of the changes in the temperature criteria applicable to some of the assessment units are discussed in Section 6.0.

Current impairment listings for the Rio Chama Watershed are included in the 2010-2012 State of New Mexico Clean Water Act §303(d)/ §305(b) Integrated List (NMED/SWQB 2010b). The Integrated List is a catalog of assessment units (AUs) throughout the state with a summary of their current status as assessed/not assessed or impaired/not impaired. Once a stream AU is identified as impaired, a TMDL guidance document is developed for that segment with guidelines for stream restoration. Target values for TMDLs are determined based on 1) applicable numeric criteria or appropriate numeric translator to a narrative standard, 2) the degree of experience in applying various management practices to reduce a specific pollutant's loading, and 3) the ability to easily monitor and produce quantifiable and reproducible results. AU names and WQS have changed over the years and the history of these individual changes is tracked in the Record of Decision document associated with the 2010-2012 Integrated List available on the SWQB website.

New Mexico's antidegradation policy is articulated in Subsection A of 20.6.4.8 NMAC. It mandates that "the level of water quality necessary to protect the existing uses shall be maintained and protected in all surface waters of the state." TMDLs are consistent with this policy because implementation of a TMDL restores water quality so that existing uses are protected and water quality criteria achieved.

2.4 Water Quality Sampling

The Rio Chama Watershed was sampled by the SWQB in 2007. A brief summary of the survey and the hydrologic conditions during the sample period is provided in the following subsections. A more detailed description can be found in Rio Chama Water Quality Survey Summary (NMED/SWQB 2011).

2.4.1 Survey Design

The Monitoring and Assessment Section (MAS) of the SWQB conducted a water quality quality survey of the Rio Chama watershed in 2007 between April and November. This water quality survey included 21 sampling sites (**Figure 2.1 and Table 2.1**). Most sites were sampled 8 times, while some secondary sites were sampled one to four times. Monitoring these sites enabled an assessment of the cumulative influence of the physical habitat, water sources, and land management activities upstream from the sites. Data results from grab sampling are housed in the SWQB provisional water quality database and were uploaded to USEPA's Storage and Retrieval (STORET) database.

All temperature and chemical/physical sampling and assessment techniques are detailed in the *Quality Assurance Project Plan* (NMED/SWQB 2006) and the SWQB assessment protocols (NMED/SWQB 2009). As a result of the 2007 monitoring effort and subsequent assessment of results, several surface water impairments were determined. Accordingly, these impairments were added to New Mexico's Integrated CWA §303(d)/305(b) List in 2010 (NMED/SWQB 2010b).

Table 2.1 SWQB 2007 Rio Chama Basin Sampling Stations

Station #	Station Description	STORET/ WQX ID
1	Canjilon Creek above Abiquiu Reservoir at US 84	29Canjil006.2
2	Cecilia Canyon Creek at FR 171	29Cecili000.1
3	Clear Creek at FR 76	29ClearC000.1
4	Placer Creek at NM 64	29Placer005.1
5	Placer Creek above Box	29Placer001.0
6	Placer Creek above Rio Vallecitos	29Placer000.1
7	Rio Capulin above Cecilia Canyon Creek	29RCapul010.3
8	Rio Chama below Rito de Tierra Amarilla above gage 08284100	29Rchama147.0
9	Rio Chama 1 mile upstream of La Puente	29RChama143.8
10	Rio Chama at NM 17	29RChama183.4
11	Rio Chama below Chama Town	29RChama174.0
13	Chama WWTP effluent	NM0027731
14	Rio Chamita above Chama WWTP outfall	29RChami002.8
15	Rio Chamita at NM 29	29RChami008.3
16	Rio Chamita below Chama WWTP outfall	29RChami002.7
17	Rio Gallina @ FR 76	29RGalli045.1
18	Rio Puerco de Chama at CR 211	29RPuerc011.0
19	Rio Puerco de Chama at FR 103	29RPuerc037.5
20	Rio Tusas above Rio Vallecitos	29RTusas000.1
21	Rito Resumidero at FR 93	29RResum002.5
22	Rito Resumidero below Resumidero Spring	29RResum001.9

2.4.2 Hydrologic Conditions

There are five active USGS gaging stations in the Rio Chama watershed with periods of record from 1912 to present day. As described in the following sections, USGS gage 08284100 was used (when appropriate) in flow calculations in the TMDLs due to its location in the watershed. The mean daily discharge for this gage was 378 cfs in 2007. **Figure 2.4** displays the mean discharge for 2007 and **Figure 2.5** displays the mean discharge for the period of record.

Table 2.2 USGS gages in the Chama Watershed (HUC 13020102)

Agency	Site Number	Site Name	Period of Record
USGS	08284100	Rio Chama near La Puente, NM	1955 – present
USGS	08285500	Rio Chama below El Vado Dam, NM	1935 – present
USGS	08286500	Rio Chama above Abiquiu Reservoir, NM	1961 – present
USGS	08287000	Rio Chama below Abiquiu Dam, NM	1961 – present
USGS	08290000	Rio Chama near Chamita, NM	1912 – present

As stated in the Assessment Protocol (NMED/SWQB 2009), data collected during all flow conditions, including low flow conditions (i.e., flows below 4-day, 3-year flows [4Q3]), will be used to determine designated use attainment status during the assessment process. For the purpose of assessing designated use attainment in ambient surface waters, WQS apply at all times under all flow conditions.

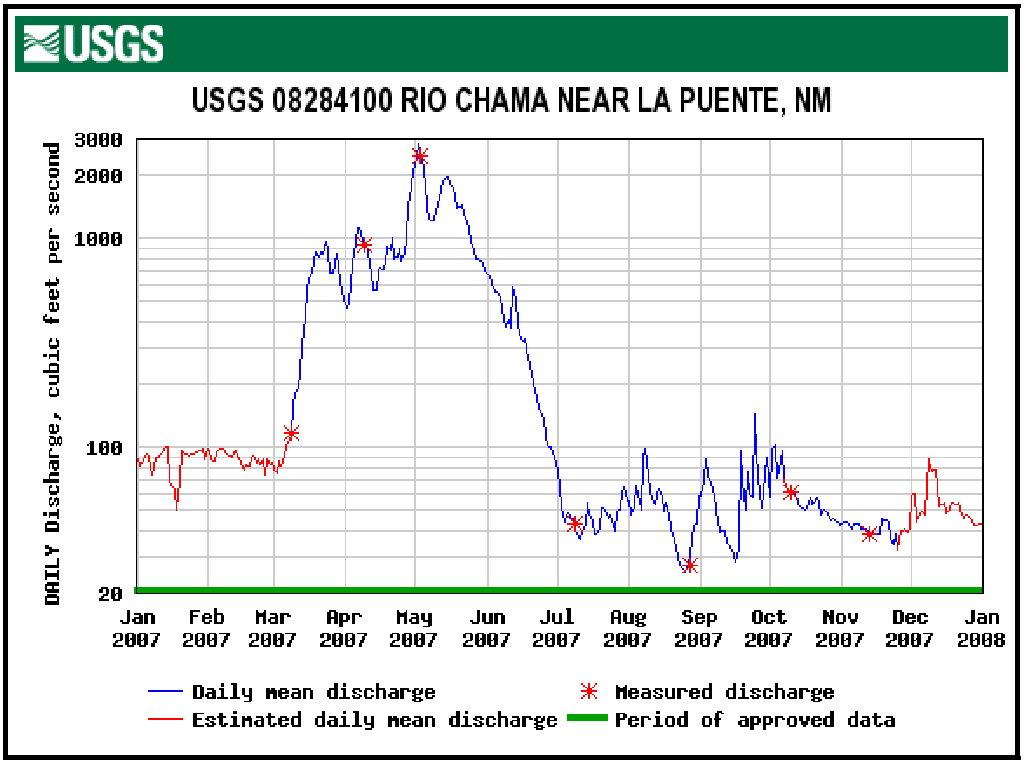


Figure 2.4 Daily mean discharge for the Rio Chama near La Puente, NM (2007)

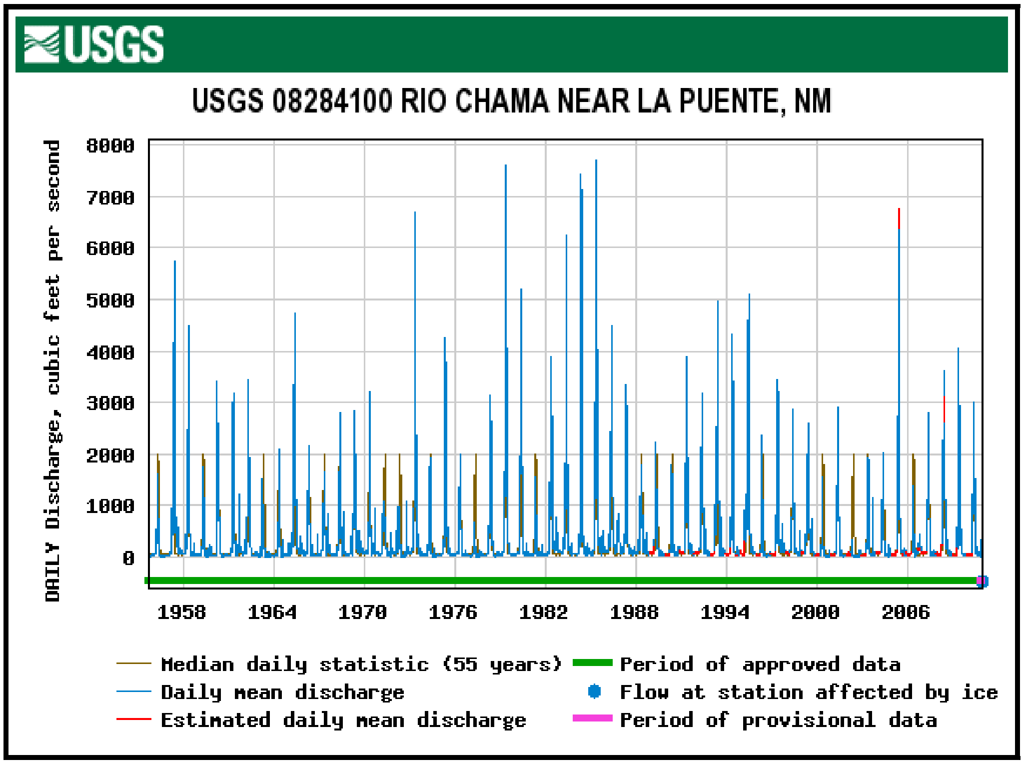


Figure 2.5 Daily mean discharge for the Rio Chama near La Puente, NM (1955 – 2010)

3.0 BACTERIA

Assessment of the data from the 2007 SWQB water quality survey in the Chama River watershed identified exceedences of the New Mexico water quality standards for *E. coli* bacteria in:

- Rio Capulin (Rio Gallina to headwaters)
- Rio Chama (El Vado Reservoir to Rio Brazos)
- Rio Chama (Little Willow Creek to CO border)
- Rio Chama (Rio Brazos to Little Willow Creek)
- Rio Chamita (Rio Chama to CO border)
- Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)

As a result, these assessment units were listed on the Integrated CWA §303(d)/§305(b) List with *E. coli* as a pollutant of concern (NMED/SWQB 2010b). Both the Rio Puerco de Chama and Rio Chamita were previously listed for fecal coliform. A TMDL for fecal coliform was developed in 1999 for the Rio Chamita AU. When water quality standards have been achieved, the reach will be moved to the appropriate category on the Clean Water Act Integrated §303(d)/§305(b) List of assessed waters.

3.1 Target Loading Capacity

For this TMDL document, target values for bacteria are based on the reduction in bacteria necessary to achieve numeric criteria:

> *20.6.4.118 NMAC: The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 410 cfu/100 mL or less.*
>
> *20.6.4.119 NMAC: The monthly geometric mean of E. coli bacteria 126 cfu/100 mL or less; single sample 235 cfu/100 mL or less.*

The presence of *E. coli* bacteria is an indicator of the possible presence of other pathogens that may limit beneficial uses and present human health concerns. Exceedences for each assessment unit are presented in Table 3.1 and *E.coli* data is in Appendix C.

Table 3.1 *E. coli* exceedences

Assessment Unit	Designated Use Affected[1]	Associated Criterion* (cfu/100mL)	Exceedence Ratio (# exceedences / total # samples)
Rio Capulin (Rio Gallina to headwaters)	SC	235	4/7
Rio Chama (El Vado Reservoir to Rio Brazos)	SC	235	2/12
Rio Chama (Little Willow Creek to CO border)	SC	235	2/7
Rio Chama (Rio Brazos to Little Willow Creek)	SC	235	2/7

Assessment Unit	Designated Use Affected[1]	Associated Criterion* (cfu/100mL)	Exceedence Ratio (# exceedences / total # samples)
Rio Chamita (Rio Chama to CO border)	SC	235	7/14
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	SC	410	2/7

Notes: * = single sample criterion

[1] = The designated use in the recently revised WQS is now Primary Contact, but the criterion remains the same. See Section 2.3 for a discussion of the revised WQS.
SC = Secondary Contact
cfu = colony forming units
mL = milliliters

3.2 Flow

TMDLs are calculated at a specific flow and bacteria concentrations can vary as a function of flow. SWQB determined streamflow during the 2007 sampling season either by using the active USGS gage network or by taking direct in-stream flow measurements utilizing standard procedures (NMED/SWQB, 2007). Water quality standard exceedences for all impaired reaches occurred during lower flows (Appendix C). Therefore, for these reaches, the critical flow value used to calculate the TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day flow that occurs with a frequency of at least once every 3 years. Critical low flow was determined on an annual basis utilizing all available daily flow values rather than on a seasonal basis for these TMDLs because exceedences occurred across both low and high flow conditions.

When available, USGS gages are used to estimate the critical flow. There are five gages that were active in the Chama Watershed around the time of the water quality survey and data collection efforts (Table 3.2). The 4Q3 flow for Rio Chama (El Vado Reservoir to Rio Brazos) was estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006b). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution.

Table 3.2 USGS gages in the Chama Watershed (HUC 13020102)

Agency	Site Number	Site Name	Period of Record
USGS	08284100	Rio Chama near La Puente, NM	1955 – present
USGS	08285500	Rio Chama below El Vado Dam, NM	1935 – present
USGS	08286500	Rio Chama above Abiquiu Reservoir, NM	1961 – present
USGS	08287000	Rio Chama below Abiquiu Dam, NM	1961 – present
USGS	08290000	Rio Chama near Chamita, NM	1912 – present

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods - typically found in the summer or fall - across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year.

The calculated 4Q3 using DFLOW software is:

- Rio Chama (El Vado Reservoir to Rio Brazos) = 17.6 cfs

It is often necessary to estimate a critical flow for a portion of a watershed where there is no active USGS flow gage. It is possible to extrapolate a known streamflow duration and/or return interval at a gaged site to an ungaged site by using a drainage-area ratio adjustment. This extrapolation is recommended only when the drainage-area ratio between the gaged and ungaged watersheds is between 0.5 and 1.5 (Thomas et al. 1997). In cases where the recommended area ratio is outside of this range, as is the case between the lower Rio Chama (gaged site) and the upper Rio Chama and Rio Chamita (ungaged sites), analysis methods developed by Waltemeyer (2002) can both be used to estimate flow. In Waltemeyer's analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 3-1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average standard error of the estimate (SEE) and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer, 2002). The 4Q3s for Rio Capulin, the upper Rio Chama, Rio Chamita, and Rio Puerco de Chama were estimated using the regression equation for mountainous regions (Eq. 3-1) because the mean elevations for these assessment units were above 7,500 feet in elevation (Table 3.3).

Table 3.3 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean Winter Precipitation (in.)	Average Basin Slope (percent)	4Q3 (cfs)
Rio Capulin (Rio Gallina to headwaters)	8870	32.5	12.5	15.7	0.58

Rio Chama (Little Willow Creek to CO border)	9813	102	21.8	25.4	18.17
Rio Chama (Rio Brazos to Little Willow Creek)	9220	219	17.9	21.7	12.3
Rio Chamita (Rio Chama to Colorado border)	8602	43.8	15.2	17.8	1.71
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	8067	202	10.5	17.3	1.28

A critical flow value of 4.1 cfs (2.65 mgd) was used for the NPDES permit for the Village of Chama WWTP, effective July 1, 2007, to calculate water quality-based effluent limits. This value was based on the 4Q3 calculated in the ***Total Maximum Daily Load For the Rio Chamita From The Confluence Of The Rio Chama To The New Mexico-Colorado Border August 1999*** (NMED/SWQB 1999b). The document used a method based on watershed size above the point of discharge that incorporates precipitation estimates to calculate a representative 7Q2 low-flow (Borland 1970). The 4Q3 was then estimated by multiplying the calculated 7Q2 value by the 4Q3/7Q2 ratio from the nearest gage, which is Rio Chama near La Puente (USGS 08284100).

Instantaneous streamflows measured by SWQB in 2006 and 2007 are presented in Section 4.0 (Table 4.6). The Rio Chamita experienced high flow during the spring snow melt tapering off to low flow conditions in the early summer months. Flow increased with summer monsoon rains and again tapered off to low flow conditions in October. Also of note, 3 out of 9 measurements are below 1.0 cfs. For this reason the SWQB decided to use the more conservative 4Q3 value (1.71 cfs) calculated using Equation 3-1 and presented in Table 3.4.

The critical streamflow values were converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$\_\_\_\_\_ \ \frac{ft^3}{\sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{\sec}{day} \times 10^{-6} = \_\_\_\_\_ \ mgd \qquad \text{(Eq. 3-2)}$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained. Meeting the calculated TMDL may be a difficult objective.

3.3 Calculations

Bacteria standards are expressed as colony forming units (cfu) per unit volume. The *E. coli* criteria used to calculate the allowable stream loads for the impaired assessment units are listed in Table 3.4. Target loads for bacteria are calculated based on flow values, water quality standards, and a conversion factor (Equation 3-3). The more conservative monthly geometric mean criteria are utilized in TMDL calculations to provide an implicit MOS. Furthermore, if the single sample criteria were used as targets, the geometric mean criteria may not be achieved.

*C as cfu/100 mL * 1,000 mL/1 L * 1 L/ 0.264 gallons * Q in 1,000,000 gallons/day = cfu/day* (Eq. 3-3)

Where C = the water quality criterion for bacteria,
Q = the critical stream flow in million gallons per day (mgd)

Table 3.4 Calculation of target loads for *E.coli*

Assessment Unit	Critical Flow (mgd)	*E.coli* geometric mean criteria (cfu/100mL)	Conversion Factor[(a)]	Target Load Capacity (cfu/day)
Rio Capulin (Rio Gallina to headwaters)	0.38	126	3.79×10^7	1.80×10^9
Rio Chama (El Vado Reservoir to Rio Brazos)	11.38	126	3.79×10^7	5.43×10^{10}
Rio Chama (Little Willow Creek to CO border)	11.74	126	3.79×10^7	5.61×10^{10}
Rio Chama (Rio Brazos to Little Willow Creek)	8.0	126	3.79×10^7	3.82×10^{10}
Rio Chamita (Rio Chama to Colorado border)	1.11	126	3.79×10^7	5.28×10^9
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	0.82	126	3.79×10^7	3.94×10^9

Notes: *(a)* Based on equation 3-2.

The measured loads for *E.coli* were similarly calculated. The arithmetic mean of the data used to determine the impairment was substituted for the criterion in Equation 3-3. The same conversion factor was used. Results are presented in Table 3.5.

Table 3.5 Calculation of measured loads for *E.coli*

Assessment Unit	Critical Flow (mgd)	*E.coli* Arithmetic Mean[(a)] (cfu/100mL)	Conversion Factor[(b)]	Measured Load (cfu/day)
Rio Capulin (Rio Gallina to headwaters)	0.38	300	3.79×10^7	4.27×10^9
Rio Chama (El Vado Reservoir to Rio Brazos)	11.38	819	3.79×10^7	3.53×10^{11}

Rio Chama (Little Willow Creek to CO border)	11.74	1382	3.79×10^{7}	6.15×10^{11}
Rio Chama (Rio Brazos to Little Willow Creek)	8.0	1396	3.79×10^{7}	4.23×10^{11}
Rio Chamita (Rio Chama to Colorado border)	1.11	1385	3.79×10^{7}	5.80×10^{10}
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	0.82	1812	3.79×10^{7}	5.66×10^{10}

Notes: *(a)* Arithmetic mean of the measured values used to make the impairment determination.
(b) Based on equation 3-3.

3.4 Waste Load Allocations and Load Allocations

3.4.1 Waste Load Allocation

There are no active point source dischargers on Rio Capulin, Rio Puerco de Chama, or both the (Little Willow Creek to CO border) or (Rio Brazos to Little Willow Creek) AUs on the Rio Chama. However, there are existing point sources with individual NPDES permits in the Rio Chamita and Rio Chama (El Vado Reservoir to Rio Brazos) assessment units. The Los Ojos Fish Hatchery (NM0030139) discharges to an unnamed irrigation ditch, Burns Canyon Lake, La Puente Irrigation Ditch, and then the Rio Chama. The Los Ojos Fish Hatchery does not have bacteria limitations in its current permit, the May 2006 EPA Statement of Basis states *"this permit does <u>not</u> authorize any discharge of sanitary waste and limitations for bacteria are not required."* However, there are no *E.coli* data available to assess whether wildlife use of the ponds contribute to the *E.coli* load in the Rio Chama. A WLA will be assigned to the facility in order to be both protective of the in-stream water quality as well as the liability of the permitee. SWQB suggests monitoring the effluent for *E.coli* twice a month.

The Village of Chama wastewater treatment plant (WWTP) (NM0027731) discharges directly into Rio Chamita and has a wasteload allocation (WLA) included in this TMDL (Table 3.6).

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in these AUs. However, excess bacteria concentrations may be a component of some storm water discharges covered under general NPDES permits, so the load for these dischargers should addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

Table 3.6 Waste Load Allocations for *E. coli*

Assessment Unit	Facility	Design Capacity Flow (mgd)	*E. coli* Effluent Limit[(a)] (cfu/100mL)	Conversion Factor[(b)]	Waste Load Allocation (cfu/day)
Rio Chama (El Vado Reservoir to Rio Brazos)	**NM0030139** Los Ojos Fish Hatchery (August 31, 2011 expiration)	2.82[c]	126	3.79×10^{7}	1.35×10^{10}
Rio Chamita (Rio Chama to CO border)	**NM0027731** Village of ChamaWWTP (September 30, 2010 expiration)	0.30	126	3.79×10^{7}	1.43×10^{9}

Notes: *(a)* Based on current in-stream New Mexico WQS for segment 20.6.4.319 NMAC.
(b) Based on equation 3-3.
(c) Based on design capacity for the WWTP and the 24-month highest discharge for the Fish Hatchery.

3.4.2 Load Allocation

In order to calculate the LA, the WLA and margin of safety (MOS) were subtracted from the target capacity TMDL following Equation 4-3:

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 3-4)}$$

The MOS is estimated to be 10 percent of the target load calculated in Table 3.4. Results are presented in Table 3.7. Additional details on the MOS chosen are presented in Section 3.7.

The extensive data collection and analyses necessary to determine background *E.coli* loads for the Rio Chama watershed were beyond the resources available for this study. It is therefore assumed that a portion of the LA is made up of natural background loads.

It is important to note that WLAs and LAs are estimates based on a specific flow condition. Under differing hydrologic conditions, the loads will change. For this reason the load allocations given here are less meaningful than are the relative percent reductions. Successful implementation of this TMDL will be determined based on achieving the *E. coli* standards.

Table 3.7 TMDL for *E.coli*

Assessment Unit	WLA (cfu/day)	LA (cfu/day)	MOS (10%) (cfu/day)	TMDL (cfu/day)
Rio Capulin (Rio Gallina to headwaters)	0	1.62×10^{9}	1.80×10^{8}	1.80×10^{9}
Rio Chama (El Vado Reservoir to Rio Brazos)	1.35×10^{10} [(a)]	3.54×10^{10}	5.43×10^{9}	5.43×10^{10}
Rio Chama (Little Willow Creek to CO border)	0	5.05×10^{10}	5.61×10^{9}	5.61×10^{10}
Rio Chama (Rio Brazos to Little Willow Creek)	0	3.44×10^{10}	3.82×10^{9}	3.82×10^{10}
Rio Chamita (Rio Chama to Colorado border)	1.43×10^{9}	3.32×10^{9}	5.28×10^{8}	5.28×10^{9}
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	0	3.55×10^{9}	3.94×10^{8}	3.94×10^{9}

Notes: [(a)]See discussion in Section 3.4.1

SWQB often includes a table that displays the percent reduction necessary for each AU with a TMDL in this document. However, SWQB recognizes that for this TMDL calculating a percent reduction is particularly challenging. This is largely because the samples collected and the impairment determinations are based on exceedences of the State's single sample criterion and the TMDL is written to the address the monthly geometric mean standard. Therefore, SWQB will not include a table discussing the percent reduction necessary to meet the *E.coli* WQS.

3.5 Identification and Description of Pollutant Source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Probable sources that may be contributing to the observed load are displayed in Table 3.8:

Table 3.8 Pollutant source summary for *E.coli*

Assessment Unit	Pollutant Sources	Magnitude[(a)] (lbs/day)	Probable Sources[(b)] (% from each)
Rio Capulin	Point:	n/a	0%
(Rio Gallina to headwaters)	Nonpoint:	4.27×10^9	100% Unknown sources.
Rio Chama (El Vado Reservoir to Rio Brazos)	Point:	1.35×10^{10}	3.7% Municipal point source discharges.
	Nonpoint:	3.53×10^{11}	96.3% Camgrounds, *rangeland grazing, bridges/culverts/railroad crossings, roads (paved and gravel) angling pressure.*
Rio Chama (Little Willow Creek to CO border)	Point:	n/a	0%
	Nonpoint:	6.15×10^{11}	100% *Rangeland grazing, impervious surfaces, residences, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel) angling pressure.*
Rio Chama (Rio Brazos to Little Willow Creek)	Point:	n/a	0%
	Nonpoint:	4.23×10^{11}	100% Flow alterations from water diversions, loss of riparian habitat, rangeland grazing, steambank modifications/destabilization. *Cattle/livestock use, rangeland grazing, stormwater runoff due to construction, residences, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel) angling pressure, highway/ raod/bridge runoff, angling pressure, dumping trash/litter, hiking trails, campgrounds, waste from pets, wildlife other than waterfowl.*
Rio Chamita (Rio Chama to Colorado border)	Point: NM0027731	1.43×10^9	2.5% Municipal point source discharges.
	Nonpoint:	5.80×10^{10}	97.5% Flow alterations from water diversions, loss of riparian habitat, natural sources, rangeland grazing, steambank modifications/destabilization. *Bridges/culverts/railroad crossings, roads (paved, dirt, and gravel), hiking trails, campgrounds, waste from pets, waterfowl, wildlife other than waterfowl, urban runoff, residences, pavement/impervious surfaces, angling pressure.*
Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	Point:	n/a	0%
	Nonpoint:	5.66×10^{10}	100% Loss of riparian habitat, rangeland grazing, *cattle/livestock use, landfill, on-site treatment systems, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel),residences, pavement.*

Notes:
(a) Measured Load (Table 3.5). *Point source* magnitude is based on the WLA calculation from NPDES permit (Table 3.6).
(b) From the Integrated CWA 303(d)/305(b) List (NMED/SWQB 2010b). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.
Italicized **Probable Sources were noted during the 2007 water quality survey.**

The Probable Source Identification Sheets in Appendix B provide an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each impairment. Table 3.8 displays probable sources of impairment along the reach as determined by field reconnaissance and assessment. Probable sources of *E.coli* will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

3.6 Linkage of Water Quality and Pollutant Sources

Among the probable sources of bacteria are municipal point source discharges such as wastewater treatment facilities, poorly maintained or improperly installed (or missing) septic tanks, livestock grazing of valley pastures and riparian areas, upland livestock grazing, in addition to wastes from pets, waterfowl, and other wildlife. Howell et. al. (1996) found that bacteria concentrations in underlying sediment increase when cattle (*Bos taurus*) have direct access to streams, such as the waters in the Cimarron River Watershed. Natural sources of bacteria are also present in the form of other wildlife such as elk, deer, and any other warm-blooded mammals. In addition to direct input from grazing operations and wildlife, *E. coli* concentrations may be subject to elevated levels as a result of resuspension of bacteria laden sediment during storm events. Temperature can also play a role in bacteria concentrations. Howell et. al. (1996) observed that bacteria growth increases as water temperature increases, which has the potential to occur in this watershed as well.

The bacteria loading in the Rio Chama watershed probably originates from a combination of drought-related impacts, municipal point source discharges, and livestock and wildlife wastes. Habitat modifications such as loss of riparian habitat, road maintenance and runoff, and land development or redevelopment as well as other recreational pollution sources may also be important contributors of bacteria.

In order to determine exact sources and relative contributions, further study is needed. One method of characterizing sources of bacteria is a Bacterial, or Microbial, Source Tracking (BST) study. The extensive data collection and analyses necessary to determine bacterial sources were beyond the resources available for this study. However, sufficient data exist to support development of *E.coli* TMDLs to address the stream standards violations.

3.7 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For these bacteria TMDLs, the MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Therefore, this MOS is the sum of the following assumptions:

- *Conservative Assumptions*
  E.coli bacteria does not readily degrade in the environment.

  Using the monthly geometric mean criterion rather than the single sample criterion, which allows for higher concentrations in individual grab samples, to calculate target loading values.

- *Explicit recognition of potential errors*
  There is inherent error in all flow measurements. A conservative MOS for this element is **10 percent**.

3.8 Consideration of Seasonal Variation

Federal regulations (40 CFR §130.7(c)(1)) require that TMDLs take into consideration seasonal variation in watershed conditions and pollutant loading. Data used in the calculation of these TMDLs were collected during the spring, summer, and fall of 2007 in order to ensure coverage of any potential seasonal variation in the system. Bacteria exceedences occurred during both high and low flow events. Higher flows may flush more nonpoint source runoff containing bacteria. It is possible the criterion may be exceeded under a low flow condition when there is insufficient dilution. Evaluation of seasonal variability for potential nonpoint sources is difficult due to limited available data.

3.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Rio Arriba County population is projected to grow by a total of 9.6 percent over the 2005-2035 period. However, as of 2009, the largest incorporated town in the watershed, Chama, had an estimated population of 1,345 people which is up from the 2000 Census population of 1,199.

According to the data, bacteria loading is primarily due to diffuse nonpoint sources. Estimates of future growth are not anticipated to lead to a significant increase in bacteria concentrations that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

4.0 PLANT NUTRIENTS

The potential for excessive nutrients in Canjilon Creek, Rio Chama (El Vado to Little Willow Creek), Rio Chamita, Rio Puerco de Chama, and Rio Tusas were noted through visual observation (Level 1 Nutrient Survey) during the 2007 watershed survey. Further assessment of various water quality parameters (Level 2 Nutrient Survey) indicated nutrient impairment in Rio Chama (El Vado Reservoir to Rio Brazos), Rio Chama (Rio Brazos to Little Willow Creek), Rio Chamita (Rio Chama to the Colorado border), and Rio Tusas (Rio Vallecitos to headwaters).

4.1 Target Loading Capacity

For this TMDL document the target value for plant nutrients is based on numeric translators for the narrative criterion set forth in Subsection E of 20.6.4.13 NMAC:

> ***Plant Nutrients:*** *Plant nutrients from other than natural causes shall not be present in concentrations which will produce undesirable aquatic life or result in the dominance of nuisance species in surface waters of the state.*

There are two potential contributors to nutrient enrichment in a given stream: excessive nitrogen and/or phosphorus. The reason for controlling plant growth is to preserve aesthetic and ecologic characteristics along the waterway. The intent of criteria for phosphorus and nitrogen is to control the excessive growth of attached algae and higher aquatic plants that can result from the introduction of these plant nutrients into streams. Numeric criteria or translators are necessary to establish targets for TMDLs, to develop water quality-based permit limits and source control plans, and to support designated uses within the watershed.

Phosphorous is found in water primarily as ortho-phosphate. In contrast nitrogen may be found as several dissolved species all of which must be considered in loading. Total Nitrogen is defined as the sum of Nitrate+Nitrite (N+N), and Total Kjeldahl Nitrogen (TKN). At the present time, there is no EPA-approved method to test for Total Nitrogen (TN), however a combination of EPA method 351.2 (TKN) and EPA method 353.2 (Nitrate + Nitrite) is appropriate for estimating Total Nitrogen.

Development of numeric translators for the plant nutrients criterion is the result of a three-step analysis. First, the EPA compiled nutrient data from the national nutrient dataset, divided it by waterbody type, grouped it into nutrient ecoregions, and calculated the 25th percentiles for each Level III ecoregion. EPA published these recommended water quality criteria to help states and tribes reduce problems associated with excess nutrients in waterbodies in specific areas of the country (USEPA 2000). Next a U.S. Geological Survey (USGS) employee, Evan Hornig, who assisted EPA Region 6 with nutrient criteria development, refined the recommended ecoregional nutrient criteria. Hornig used regional nutrient data from EPA's Storage and Retrieval System (STORET), the USGS, and the SWQB to create a regional dataset for New Mexico. Threshold values were calculated based on EPA procedures and the median for each Level III ecoregion.

The third round of analysis was conducted by SWQB to produce nutrient threshold values for streams based on ecoregion and designated aquatic life use. For this analysis, total phosphorus (TP), total Kjeldahl nitrogen (TKN), and nitrate plus nitrite (N+N) data from the National

Nutrient Dataset (1990-1997) were combined with Archival STORET data from 1998, and 1999-2006 data from the SWQB in-house database. The data were then divided by waterbody type, removing all rivers, reservoirs, lakes, wastewater treatment effluent, and playas. For all of the stream data, Level III and IV Omernik ecoregions (Omernik 2006) as well as the designated aquatic life use were assigned using GIS coverages and the station's latitude and longitude. Medians were calculated for each ecoregion/aquatic life use group. For comparison purposes, values below the detection limit were estimated in two ways; using the substitution method (one half the detection limit) in Excel and using the nonparametric Kaplan-Meier method in Minitab. The threshold values from the SWQB Stream Nutrient Assessment Protocol are shown in Table 4.1. They were generated with the complete dataset using the substitution method given that the substitution and Kaplan-Meier methods produced similar results.

Table 4.1 SWQB's nutrient thresholds for Southern Rockies (in mg/L)

	Southern Rockies	
Aquatic Life Use →	CW	T/WW (volcanic)
Total Phosphorus	0.02	0.02 (0.05)
Total Nitrogen	0.25	0.25

NOTES: CW = Coldwater (those water quality (WQ) segments having only CW uses)
T = Transitional (those WQ segments with marginal CW or both CW and WW uses)
WW = Warmwater (those WQ segments having only WW uses)

Rio Tusas (Rio Vallecitos to headwaters) is located in the Southern Rockies. In addition, Rio Tusas has both coldwater and warmwater uses, therefore it is classified as transitional for assessment purposes (20.6.4.116 NMAC). According to Table 4.1, this stream should have nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen.

Rio Chama (El Vado to Rio Brazos) and Rio Chama (Rio Brazos to Little Willow Creek) are designated as high quality coldwater aquatic life (20.6.4.119 NMAC) and are located in the Southern Rockies. According to Table 4.1, the Rio Chama should have nutrient targets of 0.02 mg/L for total phosphorus and 0.25 mg/L for total nitrogen. However, SWQB's water quality survey and assessment indicated the river is fully supporting its designated uses in the upper Rio Chama (Little Willow Creek to the Colorado border) where average nutrient concentrations were 0.07 mg/L for total phosphorus and 0.25 mg/L for total nitrogen. ***Since the upstream values have proven to be effective at maintaining water quality standards and fully supporting the designated uses, they are being recommended as the in-stream target concentrations for the lower Rio Chama assessment units.***

Rio Chamita (Rio Chama to the Colorado Border) is designated as high quality coldwater aquatic life (20.6.4.119 NMAC) and is located in the Southern Rockies. According to Table 4.1, this creek has nutrient targets of 0.02 mg/L for TP and 0.25 mg/L for TN. However the Rio Chamita is a comparable watershed to the Rio Hondo (Table 4.2) and the target concentrations from the *Total Maximum Daily Load for the Rio Hondo (South Fork to Lake Fork Creek)*(NMED/SWQB, 2005). provide an alternative approach. In addition, these nutrient targets, 0.10 mg/L or less for TP and 1.0 mg/L or less for TN, have proven to be effective at maintaining water quality standards and fully supporting the designated uses of the Rio Hondo and as such are appropriate target for the Rio Chamita. The in-stream target concentrations that have proven effective in the Rio Hondo are 0.10 mg/L or less for TP and 1.0 mg/L or less for TN. *These targets will be lowered to the targets in Table 4.1 if water quality in the Rio Chamita does not improve after implementation*. This phased strategy will require data collection to determine if the load reductions achieved using these target concentrations actually lead to attainment of water quality standards. The next tentatively scheduled monitoring date for the Rio Chamita subwatershed is 2012.

Table 4.2 Comparison of Rio Chamita and Rio Hondo for In-Stream Target Evaluation

Watershed	Designated Uses*	Watershed Area (mi^2)	Ecoregion	4Q3 (mgd)	Design Capacity (mgd)	Mean Winter Precipitation (in.)
Rio Chamita	DWS, FC, LW, WH, HQCWAL, IRR, and secondary contact	43.0	Southern Rockies	1.11	0.30	15.2
Rio Hondo	DWS, FC, LW, WH, HQCWAL, IRR, and secondary contact	20.9	Southern Rockies	3.63	0.20	14.2

* DWS = domestic water supply; FC = fish culture; LW = livestock watering; WH = wildlife habitat; HQCWAL = high quality coldwater aquatic life; IRR = irrigation

Table 4.3 In-stream nutrient target concentrations

Assessment Unit	Total Phosphorus	Total Nitrogen
Rio Chama (El Vado Reservoir to Rio Brazos)	0.07 mg/L	0.25 mg/L
Rio Chama (Rio Brazos to Little Willow Creek)	0.07 mg/L	0.25 mg/L
Rio Chamita (Rio Chama to the Colorado Border)	0.1 mg/L	1.0 mg/L
Rio Tusas (Rio Vallecitos to headwaters)	0.02 mg/L	0.25 mg/L

4.2 Critical Flow

The presence of plant nutrients in a stream can vary as a function of flow. Higher nutrient concentrations typically occur during low-flow conditions because there is reduced stream capacity to assimilate point source discharges due to less streamflow available for dilution. In other words, as flow decreases, the stream cannot effectively dilute its constituents causing the concentration of plant nutrients to increase.

The critical flow condition for the Rio Chamita occurs when the ratio of effluent to stream flow is the greatest and was obtained using a 4Q3 regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect low flows have on nutrient concentrations and algal growth.

Table 4.4 USGS gages in the Chama Watershed (HUC 13020102)

Agency	Site Number	Site Name	Period of Record
USGS	08284100	Rio Chama near La Puente, NM	1955 – present
USGS	08285500	Rio Chama below El Vado Dam, NM	1935 – present
USGS	08286500	Rio Chama above Abiquiu Reservoir, NM	1961 – present
USGS	08287000	Rio Chama below Abiquiu Dam, NM	1961 – present
USGS	08290000	Rio Chama near Chamita, NM	1912 – present

When available, U.S. Geological Survey (USGS) streamflow gages are used to estimate flow. There were five active gages in the Chama Watershed during the time of the water quality survey and data collection efforts (Table 4.4). The 4Q3 flow for the Rio Chama (El Vado Reservoir to Rio Brazos) is based on USGS gage data. Rio Chama near La Puente, NM (USGS Gage 08284100) is located in the Rio Chama (El Vado Reservoir to Rio Brazos) assessment unit (AU). The 4Q3 was estimated using the USGS A193 calculation for Log Pearson Type III distribution through DFLOW software, Version 3.1b (USEPA 2006b). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis.

A climatic year starting April 1 of the prior year and ending March 31 is often used when examining critical low flow conditions in the United States. This choice reduces the likelihood of splitting low flow periods, typically found in the summer or fall, across different years and thereby affecting the results of Log Pearson Type III analysis of series of annual low flows. A different climatic year or shorter season may be used if low flow periods occur at other times of the year or overlap the boundaries of the climatic year. The calculated 4Q3 using gage data and DFLOW software is as follows:

- Rio Chama (El Vado Reservoir to Rio Brazos) = 17.6 cfs

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. It is possible to extrapolate a known streamflow duration and/or return interval at a gaged site to an ungaged site by using a drainage-area ratio adjustment. This extrapolation is recommended only when the drainage-area ratio between the gaged and ungaged watersheds is between 0.5 and 1.5 (Thomas et al. 1997). In cases where the recommended areal ratio is outside of this range, as is the case between the lower Rio Chama (gaged site) and the upper Rio Chama, Rio Chamita, and Rio Tusas (ungaged sites), analysis methods developed by Borland (1970) and Waltemeyer (2002) can both be used to estimate flow. For the current TMDL analysis, Waltemeyer's method was chosen because it is based on more recent flow data, it directly calculates the 4Q3 value (unlike Borland's method which calculates the 7Q2), it is specific to mountainous regions above 7,500 feet in elevation, and it is more consistent the actual flow data that was collected by SWQB in the 2007 water quality survey.

Waltemeyer (2002) developed two regression equations for estimating 4Q3 based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35} \qquad \text{(Eq. 4-1)}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 low-flow frequencies for the Rio Chama, Rio Chamita, and Rio Tusas, estimated using Equation 4-1, are presented in Table 4.5.

Table 4.5 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average elevation (ft)	Drainage area (mi^2)	Mean winter precipitation (in)	Average basin slope	4Q3 (cfs)
Rio Chama (Rio Brazos to Little Willow Creek)	9220	219	17.9	21.7%	12.3
Rio Chamita (Rio Chama to Colorado border)	8602	43.8	15.2	17.8%	1.71
Rio Tusas (Rio Vallecitos to headwaters)	8484	197	10.3	17.1%	1.15

A critical flow value of 4.1 cfs (2.65 mgd) was used for the NPDES permit for the Village of Chama WWTP, effective July 1, 2007, to calculate water quality-based effluent limits. This value was based on the 4Q3 calculated in the ***Total Maximum Daily Load For the Rio Chamita***

From The Confluence Of The Rio Chama To The New Mexico-Colorado Border August 1999 (NMED/SWQB, 1999b). The document used a method based on watershed size above the point of discharge that incorporates precipitation estimates to calculate a representative 7Q2 low-flow (Borland 1970). The 4Q3 was then estimated by multiplying the calculated 7Q2 value by the 4Q3/7Q2 ratio from the nearest gage, which is Rio Chama near La Puente (USGS 08284100).

Instantaneous streamflows measured by SWQB in 2006 and 2007 are presented in Table 4.6. The Rio Chamita experienced high flow during the spring snow melt tapering off to low flow conditions in the early summer months. Flow increased with summer monsoon rains and again tapered off to low flow conditions in October. Also of note, 3 out of 9 measurements are below 1.0 cfs. For this reason the SWQB decided to use the more conservative 4Q3 value (1.71 cfs) calculated using Equation 4-1 and presented in Table 4.5.

Table 4.6 Actual Streamflow Measurements made by SWQB

Sample site	STORET ID	Collection Date	Flow (cfs)
Rio Chamita below Chama WWTP outfall	29RChami002.7	9/6/2006	9.78
Rio Chamita below Chama WWTP outfall	29RChami002.7	4/3/2007	42.93
Rio Chamita below Chama WWTP outfall	29RChami002.7	5/15/2007	54.56
Rio Chamita below Chama WWTP outfall	29RChami002.7	6/20/2007	0.85
Rio Chamita below Chama WWTP outfall	29RChami002.7	7/12/2007	0.93
Rio Chamita below Chama WWTP outfall	29RChami002.7	8/7/2007	19.18
Rio Chamita below Chama WWTP outfall	29RChami002.7	9/5/2007	17.97
Rio Chamita below Chama WWTP outfall	29RChami002.7	9/18/2007	17.05
Rio Chamita below Chama WWTP outfall	29RChami002.7	10/2/2007	0.37

The 4Q3 value for Rio Chamita was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows:

$$1.71\frac{ft^3}{\sec}\times 1{,}728\frac{in^3}{ft^3}\times 0.004329\frac{gal}{in^3}\times 86{,}400\frac{\sec}{day}\times 10^{-6} = 1.11mgd$$

The 4Q3 values for the other waterbodies were converted in a similar manner.

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained.

4.3 Calculations

This section describes the relationship between the numeric target and the allowable pollutant-level by determining the waterbody's total assimilative capacity, or loading capacity, for the pollutant. The loading capacity is the maximum amount of pollutant loading that a waterbody can receive while meeting its water quality objectives.

As a river flows downstream it has a specific carrying capacity for nutrients. This carrying capacity is defined as the mass of pollutant that can be carried under critical low-flow conditions without violating the target concentration for that constituent. The specific carrying capacity of a receiving water for a given pollutant, may be estimated using Equation 4-2.

Flow (mgd) x Numeric Target (mg/L) x 8.34 = TMDL (pounds per day [lbs/day]) (Eq. 4-2)

The daily target loads for TP and TN are summarized in Table 4.7.

Table 4.7 Daily Target Loads for TP & TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Numeric Target (mg/L)	Conversion Factor	TMDL (lbs/day)
Rio Chama (El Vado Rsvr to Rio Brazos)	Total Phosphorus	11.4	0.07✧	8.34	6.66
	Total Nitrogen	11.4	0.25✧	8.34	23.8
Rio Chama (Rio Brazos to Little Willow Creek)	Total Phosphorus	7.97	0.07✧	8.34	4.65
	Total Nitrogen	7.97	0.25✧	8.34	16.6
Rio Chamita (Rio Chama to CO border)	Total Phosphorus	1.41+	0.10*	8.34	1.18
	Total Nitrogen	1.41+	1.0*	8.34	11.8
Rio Tusas (Rio Vallecitos to headwaters)	Total Phosphorus	0.74	0.02	8.34	0.124
	Total Nitrogen	0.74	0.25	8.34	1.55

Notes:
✧ *Based on in-stream concentrations from the upper Rio Chama (Little Willow Creek to Colorado border) that have proven to be effective at maintaining water quality standards and fully supporting the designated uses of Rio Chama (El Vado Reservoir to Little Willow Creek). These targets may be lowered if water quality does not improve after implementation.*
\+ *Combined Flow = 4Q3 low-flow (1.11 mgd) + Village of Chama WWTP design capacity (0.30 mgd)*
* *Based on in-stream target concentrations from a comparable watershed that have proven to be effective at maintaining water quality standards and fully supporting the designated uses of Rio Chamita. These targets may be lowered if water quality does not improve after implementation.*

The measured loads for TP and TN were similarly calculated. In order to achieve comparability between the target and measured loads, the same flow value was used for both calculations. The arithmetic mean of the collected data was substituted for the target in Equation 4-2. The same conversion factor of 8.34 was used. The results are presented in Table 4.8.

Table 4.8 Measured Loads for TP and TN

Assessment Unit	Parameter	4Q3 Flow (mgd)	Arithmetic Mean Conc.* (mg/L)	Conversion Factor	Measured Load (lbs/day)
Rio Chama (El Vado Rsvr to Rio Brazos)	Total Phosphorus	11.4	0.105	8.34	9.98
	Total Nitrogen	11.4	0.478	8.34	45.4
Rio Chama (Rio Brazos to Little Willow Creek)	Total Phosphorus	7.97	0.323	8.34	21.5
	Total Nitrogen	7.97	0.757	8.34	50.3
Rio Chamita (Rio Chama to CO border)	Total Phosphorus	1.41+	0.410	8.34	4.82
	Total Nitrogen	1.41+	3.23	8.34	38.0
Rio Tusas (Rio Vallecitos to headwaters)	Total Phosphorus	0.74	0.085	8.34	0.528
	Total Nitrogen	0.74	0.739	8.34	4.59

Notes:
* *Arithmetic mean of TP and TN concentrations from SWQB's water quality survey.*
\+ *Combined Flow = 4Q3 low-flow (1.11 mgd) + Village of Chama WWTP design capacity (0.30 mgd)*

4.4 Wasteload and Load Allocations

4.4.1 Waste Load Allocation

There are no Municipal Separate Storm Sewer System (MS4) storm water permits in these AUs. However, excess nutrient loading may be a component of some storm water discharges covered under general NPDES permits, so the load from these dischargers should be addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of a SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation.

There are no active point source dischargers on the Rio Chama (Rio Brazos to Little Willow Creek) or Rio Tusas assessment units; however, there are existing point sources with NPDES permits in the Rio Chamita and Rio Chama (El Vado Reservoir to Rio Brazos) AUs. Each NPDES-permitted facility that discharges into an impaired reach has a WLA included in this TMDL (Tables 4.9 and 4.10).

The Village of Chama WWTP (NM0027731) and Los Ojos State Fish Hatchery (NM0030139) discharge to their respective receiving waters under authorization of an NPDES permit; however both of these facilities are currently not designed to treat effluent for TP and TN. These facilities will need to develop and implement treatment to remove nutrients and improve water quality. It is the policy of the Water Quality Control Commission to allow schedules of compliance in NPDES permits when facility modifications are necessary to meet new water quality based requirements.

Nutrient removal is one of the most pressing challenges facing wastewater treatment facilities. The Village of Chama WWTP contributes approximately 89% of the measured nitrogen load and 85% of the measured phosphorus load in Rio Chamita. Current in-stream loading is three to four times that of the target load (Tables 4.7 and 4.8). Effluent data from Los Ojos Fish Hatchery collected on January 4, 2001 and submitted during their NPDES permit renewal show results of 10.5 mg/L TN and 3.72 mg/L TP; which equates to 23% and 37% of the measured loads, respectively. In addition, nutrient cycling is a very dynamic process and the hatchery does not discharge directly into the impaired reach, therefore some processing and cycling of nutrients is likely to occur before the effluent reaches the Rio Chama.

Nutrients can be removed from wastewater via biological, chemical, or combined biological and chemical processes. There are theoretical limits that can be achieved with different removal mechanisms. The limit of technology (LOT), based on annual averages, is generally considered to be 0.1 mg/L for total phosphorus (TP) and 3 mg/L for total nitrogen (TN) (Jeyanayagam 2005); however, some facilities may be able to achieve lower concentrations, depending on the removal process and site-specific conditions. TP concentrations in treated effluent typically range from 0.1 to 1.0 mg/L, while TN concentrations typically range from 3.0 to 10.0 mg/L.

Some facilities may be able to achieve lower concentrations by using a combination of biological and chemical treatments, however biological treatment is highly temperature dependent therefore seasonal limits may need to be considered in some cases. The choice of technology to be used as well as the option and use of seasonal limits depend on the site-specific conditions (e.g. temperature, dissolved oxygen levels, and pH) and the economic feasibility.

NMED believes that a TMDL should be written to targets that are protective of the stream and scientifically defensible however there should also be recognition of the limits of technology for nutrient removal. A simple, steady-state mass balance model was used to test the mixing potential and dilution capacity of the receiving waters. Because ambient, upstream concentrations are relatively high, effluent limits for the Village of Chama based on the mixing model were comparable to the limits of technology; however, effluent limits for Los Ojos Fish Hatchery were equivalent to the in-stream targets identified in Table 4.3. Based on this analysis it can be concluded that advanced treatment would significantly reduce the load of TP and TN that is introduced to the receiving waters.

After implementation of the Phase 1 effluent limits based on this TMDL and given enough time to allow the aquatic system to respond, NMED will reevaluate the conditions in the Rio Chama and Rio Chamita. At that time, if the waterbodies are still impaired for plant nutrients and there is no substantial improvement observed in the water quality of these waters, the facilities would be required to enhance the treatment of the effluent by adding more effective treatment or find other means of disposal (Figure 4.1; Tables 4.9 and 4.10).

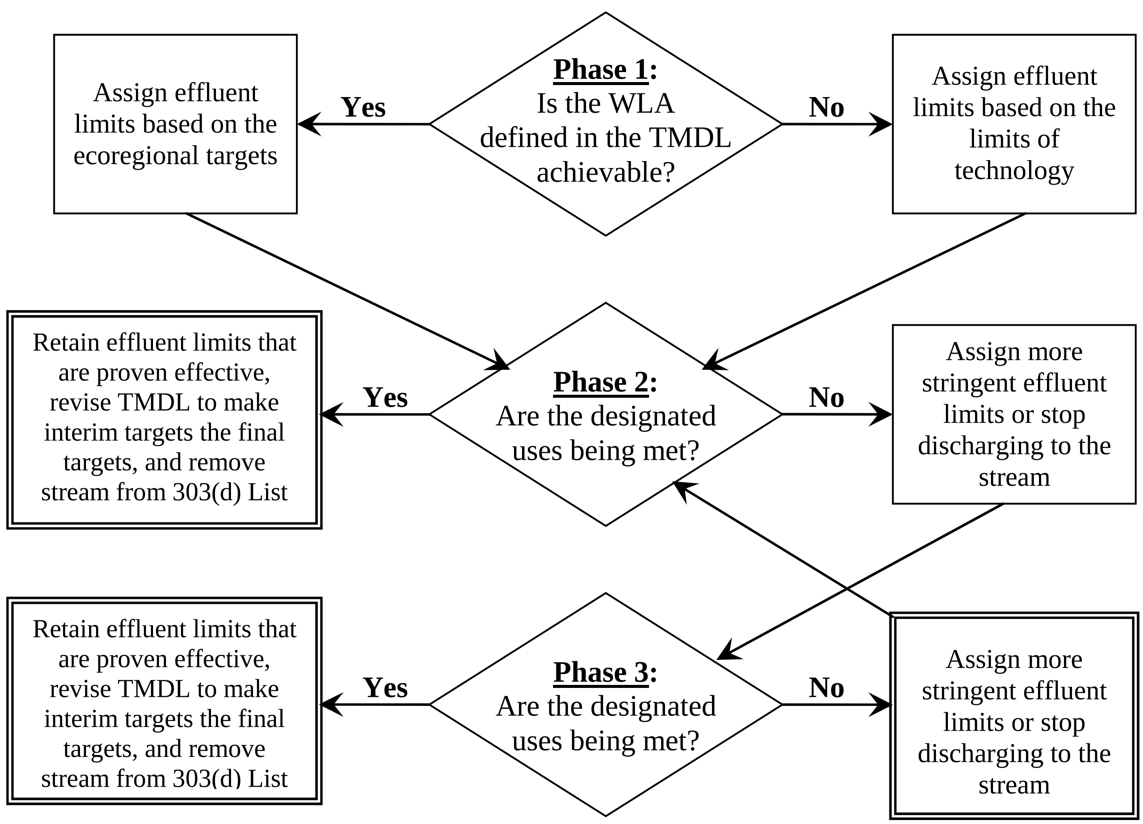


Figure 4.1 Decision process for assigning effluent limits in a phased TMDL

Table 4.9 *Phase 1* Nutrient Wasteload Allocations

Phase	Facility	Parameter	Discharge+ (mgd)	Effluent Limit (a) (mg/L)	Conversion Factor	Wasteload Allocation (lbs/day)
1st	**NM0027731** Village of Chama WWTP (expires 9/30/2010)	Total Phosphorus	0.30	0.40	8.34	1.00
		Total Nitrogen	0.30	4.0	8.34	10.0
1st	**NM0030139** Los Ojos Fish Hatchery* (expires 8/31/2011)	Total Phosphorus	2.82	0.24	8.34	5.66
		Total Nitrogen	2.82	3.0	8.34	70.6 (c)

Table 4.10 *Target* Nutrient Wasteload Allocations *(Phase "n")*

Phase	Facility	Parameter	Discharge+ (mgd)	Effluent Limit (b) (mg/L)	Conversion Factor	Wasteload Allocation (c) (lbs/day)
nth	**NM0027731** Village of Chama WWTP	Total Phosphorus	0.30	0.1	8.34	0.250
		Total Nitrogen	0.30	1.0	8.34	2.50
nth	**NM0030139** Los Ojos Fish Hatchery*	Total Phosphorus	2.82	0.07	8.34	1.65
		Total Nitrogen	2.82	0.25	8.34	5.88

Notes:
* Los Ojos Fish Hatchery does not discharge directly to the Rio Chama.
\+ Based on design capacity for the WWTP and the 24-month highest discharge for the Fish Hatchery.

(a) Phase 1 effluent limits are based on two different approaches:

1. If achievable effluent limits could be caluclated within the scope of the TMDL from Table 4.7, then Phase 1 effluent limits were backcalculated using the following formula: *Effluent Limit = WLA ÷ (discharge × conversion factor)*, with 85% of the TMDL being allocated to the wasteload allocation.
2. If achievable effluent limits could not be calculated within the scope of the TMDL from Table 4.7, then Phase 1 effluent limits were based on annual averages for the limits of technology. Biological treatment is highly temperature dependent therefore the permit may need to consider seasonal targets.

(b) Phase "n" effluent limits based on in-stream nutrient concentrations that are proven effective at maintaining water quality standards and fully supporting the designated uses of the reach (refer to Section 4.1 and Table 4.3 for more details). As of 2011, these targets are technologically unachievable.

(c) WLA = (discharge) × (effluent limit) × (conversion factor)

A phased strategy is an iterative process and will require future data collection and analysis to determine if the load reductions achieved using effluent limits that are based on alternative target concentrations actually lead to attainment of water quality standards. Please refer to "Clarification Regarding "Phased" Total Maximum Daily Loads," an August 2, 2006 memorandum from the USEPA, for more information on this topic (USEPA, 2006a). The next scheduled monitoring date for the Rio Chama Watershed is 2012 at which time the water quality of the Rio Chama and Rio Chamita watersheds will be re-examined, designated use attainment will be re-assessed, and target concentrations and waste load allocations re-evaluated.

4.4.2 Load Allocation

In order to calculate the load allocation (LA) for phosphorus and nitrogen, the WLA and margin of safety (MOS) were subtracted from the target capacity (TMDL) using the following equation:

$$LA = TMDL - MOS - WLA \qquad \text{(Eq. 4-3)}$$

The MOS was developed using a combination of conservative assumptions and explicit recognition of potential errors in flow calculations. Results using an explicit MOS of 10% (see Section 4.7 for details) are presented in Table 4.11.

Table 4.11 Calculation of TMDL for TP and TN

Assessment Unit	Parameter	WLA (lbs/day)	LA (lbs/day)	MOS (10%)	TMDL (lbs/day)
Rio Chama (El Vado Reservoir to Rio Brazos)	Total Phosphorus	1.65*	4.34	0.666	6.66
	Total Nitrogen	5.88*	15.5	2.38	23.8
Rio Chama (Rio Brazos to Little Willow Creek)	Total Phosphorus	0	4.19	0.465	4.65
	Total Nitrogen	0	15.0	1.66	16.6
Rio Chamita (Rio Chama to CO border)	Total Phosphorus	0.250*	0.808	0.118	1.18
	Total Nitrogen	2.50*	8.08	1.18	11.8
Rio Tusas (Rio Vallecitos to headwaters)	Total Phosphorus	0	0.112	0.012	0.124
	Total Nitrogen	0	1.40	0.155	1.55

Notes: * Wasteload allocations (WLAs) are the *Target* (Phase "n") Wasteload Allocations from Table 4.10, which are based on in-stream nutrient concentrations that are proven effective at maintaining water quality standards and fully supporting the designated uses of the reach. As of 2011, these wasteload allocations are technologically unachievable.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated daily target load (Table 4.7) and the measured load (Table 4.8), and are shown in Table 4.12.

Table 4.12 Calculation of Load Reduction for TP and TN

Assessment Unit	Parameter	Target Load [(a)] (lbs/day)	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction [(b)]
Rio Chama (El Vado Reservoir to Rio Brazos)	Total Phosphorus	5.99	9.98	3.99	40%
	Total Nitrogen	21.4	45.4	24.0	53%
Rio Chama (Rio Brazos to Little Willow Creek)	Total Phosphorus	4.19	21.5	17.3	80%
	Total Nitrogen	15.0	50.3	35.3	70%
Rio Chamita (Rio Chama to CO border)	Total Phosphorus	1.06	4.82	3.76	78%
	Total Nitrogen	10.6	38.0	27.4	72%
Rio Tusas (Rio Vallecitos to headwaters)	Total Phosphorus	0.112	0.528	0.416	79%
	Total Nitrogen	1.40	4.59	3.19	70%

Notes:

The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty or variability in TMDL calculations and therefore should not be subtracted from the measured load.

(a) Target Load = TMDL – MOS (refer to Table 4.11)
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

4.5 Identification and Description of Pollutant Sources

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 4.13 Pollutant Source Summary for Total Phosphorus

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Rio Chama (El Vado Reservoir to Rio Brazos)	Point: NM0030139	0[a]	0% Point source discharge
	Nonpoint:	9.98[b]	100% *Camgrounds, rangeland grazing, bridges/culverts/railroad crossings, roads (paved and gravel) angling pressure.*
Rio Chama (Rio Brazos to Little Willow Creek)	Point:	n/a	0%
	Nonpoint:	21.5	100% Flow alterations from water diversions, loss of riparian habitat, rangeland grazing, source *Cattle/livestock use, rangeland grazing, stormwater runoff due to construction, residences, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel) angling pressure, highway/ raod/bridge runoff, angling pressure, dumping trash/litter, hiking trails, campgrounds, waste from pets, wildlife other than waterfowl.*
Rio Chamita (Rio Chama to CO border)	Point: NM0027731	4.11[d]	85% Municipal point source discharge
	Nonpoint:	0.708[c]	15% Flow alterations from water diversions, loss of riparian habitat, natural sources, rangeland grazing, source *Bridges/culverts/railroad crossings, roads (paved, dirt, and gravel), hiking trails, campgrounds, waste from pets, waterfowl, wildlife other than waterfowl, urban runoff, residences, pavement/impervious surfaces, angling pressure.*
Rio Tusas (Rio Vallecitos to headwaters)	Point:	n/a	0%
	Nonpoint:	0.528	100% *Crop production, cattle/livestock use, rangeland grazing, stormwater runoff due to construction, on-site treatment systems, pavement/impervious surfaces, site clearance, bridges/culverts/railroad crossings, roads (dirt, gravel, paved), highway/road/bridge runoff, hiking trails, campgrounds, waste from pets, waterfowl, wildlife other than waterfowl.*

Notes:

a The magnitude for Los Ojos Fish Hatchery is zero because the average ambient, upstream load for TP is higher than the load in the assessment unit where it discharges (i.e. Rio Chama (El Vado Reservoir to Rio Brazos)). It appears that the Rio Chama (El Vado Reservoir to Rio Brazos) is currently a sink for phosphorus.

b Measured load from Table 4.8.

c The magnitude for nonpoint sources is the average ambient, upstream TP load.

d The magnitude for the Village of Chama WWTP is the difference between the nonpoint source load and the measured load from Table 4.8.

* From the 2010-2012 State of New Mexico CWA §303(d)/§305(b) Integrated List (NMED/SWQB 2010b). This list of probable sources is based on staff observation, known land use activities in the watershed, and is related to this particular impairment listing. These sources are not confirmed nor quantified at this time.

***Italicized* Probable Sources were noted during the 2007 water quality survey.**

Table 4.14 Pollutant Source Summary for Total Nitrogen

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)	Probable Sources* (% from each)
Rio Chama (El Vado Reservoir to Rio Brazos)	Point: NM0030139 Nonpoint:	9.55[b] 35.9[a]	21% Point source discharge 79% *Camgrounds, rangeland grazing, bridges/culverts/railroad crossings, roads (paved and gravel) angling pressure.*
Rio Chama (Rio Brazos to Little Willow Creek)	Point: Nonpoint:	n/a 50.3	0% 100% Flow alterations from water diversions, loss of riparian habitat, rangeland grazing, source *Cattle/livestock use, rangeland grazing, stormwater runoff due to construction, residences, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel) angling pressure, highway/ raod/bridge runoff, angling pressure, dumping trash/litter, hiking trails, campgrounds, waste from pets, wildlife other than waterfowl.*
Rio Chamita (Rio Chama to CO border)	Point: NM0027731 Nonpoint:	33.7[b] 4.30[a]	89% Municipal point source discharge 11% Flow alterations from water diversions, loss of riparian habitat, natural sources, rangeland grazing, source *Bridges/culverts/railroad crossings, roads (paved, dirt, and gravel), hiking trails, campgrounds, waste from pets, waterfowl, wildlife other than waterfowl, urban runoff, residences, pavement/impervious surfaces, angling pressure.*
Rio Tusas (Rio Vallecitos to headwaters)	Point: Nonpoint:	n/a 4.59	0% 100% *Crop production, cattle/livestock use, rangeland grazing, stormwater runoff due to construction, on-site treatment systems, pavement/impervious surfaces, site clearance, bridges/culverts/railroad crossings, roads (dirt, gravel, paved), highway/road/bridge runoff, hiking trails, campgrounds, waste from pets, waterfowl, wildlife other than waterfowl.*

Notes:

a The magnitude for nonpoint sources is the average ambient, upstream TN load.

b The magnitude for point sources is the difference between the nonpoint source load and the measured load from Table 4.8.

* From the 2010-2012 State of New Mexico CWA §303(d)/§305(b) Integrated List (NMED/SWQB 2010b). This list of probable sources is based on staff observation, known land use activities in the watershed, and is related to this particular impairment listing. These sources are not confirmed nor quantified at this time.

***Italicized* Probable Sources were noted during the 2007 water quality survey.**

The Probable Source Identification Sheets in Appendix B provide an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each impairment. Table 4.13 and Table 4.14 display probable sources of impairment along each reach as determined by field reconnaissance and assessment. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

4.6 Linkage between Water Quality and Pollutant Sources

The source assessment phase of TMDL development identifies sources of nutrients that may contribute to both elevated nutrient concentrations and the stimulation of algal growth in a waterbody. Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

Phosphorus and nitrogen generally drive the productivity of algae and macrophytes in aquatic ecosystems, therefore they are regarded as the primary limiting nutrients in freshwaters. The main reservoirs of natural phosphorus are rocks and natural phosphate deposits. Weathering, leaching, and erosion are all processes that breakdown rock and mineral deposits allowing phosphorus to be transported to aquatic systems via water or wind. The breakdown of mineral phosphorus produces inorganic phosphate ions ($H_2PO_4^-$, HPO_4^{2-}, and PO_4^{3-}) that can be absorbed by plants from soil or water (USEPA 1999). Phosphorus primarily moves through the food web as organic phosphorus (after it has been incorporated into plant or algal tissue) where it may be released as phosphate in urine or other waste by heterotrophic consumers and reabsorbed by plants or algae to start another cycle (Nebel and Wright 2000).

The largest reservoir of nitrogen is the atmosphere. About 80 percent of the atmosphere by volume consists of nitrogen gas (N_2). Although nitrogen is plentiful in the environment, it is not readily available for biological uptake. Nitrogen gas must be converted to other forms, such as ammonia (NH_3 and NH_4^+), nitrate (NO_3^-), or nitrite (NO_2^-) before plants and animals can use it. Conversion of gaseous nitrogen into usable mineral forms occurs through three biologically mediated processes of the nitrogen cycle: nitrogen fixation, nitrification, and ammonification (USEPA 1999). Mineral forms of nitrogen can be taken up by plants and algae and incorporated into plant or algal tissue. Nitrogen follows the same pattern of food web incorporation as phosphorus and is released in waste primarily as ammonium compounds. The ammonium compounds are usually converted to nitrates by nitrifying bacteria, making it available again for uptake, starting the cycle anew (Nebel and Wright 2000).

Rain, overland runoff, groundwater, drainage networks, and industrial and residential waste effluents transport nutrients to receiving waterbodies. Once nutrients have been transported into a waterbody they can be taken up by algae, macrophytes, and microorganisms either in the water column or in the benthos; they can adsorb to organic or inorganic particles in the water column and/or sediment; they can accumulate or be recycled in the sediment; or they can be transformed and released as a gas from the waterbody (Figure 4.2).

As noted above, phosphorus and nitrogen are essential for proper functioning of ecosystems. However, excess nutrients cause conditions unfavorable for the proper functioning of aquatic ecosystems. Nuisance levels of algae and other aquatic vegetation (macrophytes) can develop rapidly in response to nutrient enrichment when other factors (e.g., light, temperature, substrate, etc.) are not limiting (Figure 4.2). The relationship between nuisance algal growth and nutrient enrichment in stream systems has been well documented in the literature (Welch 1992; Van Nieuwenhuyse and Jones 1996; Dodds et al. 1997; Chetelat et al. 1999). Unfortunately, the magnitude of nutrient concentration that constitutes an “excess” is difficult to determine and varies by ecoregion.

As described in Section 4.2, the presence of plant nutrients in a stream can vary as a function of flow. As flow decreases through water diversions and/or drought-related stressors, the stream cannot effectively dilute its constituents, which causes the concentration of plant nutrients to increase. Nutrients generally reach a waterbody from land uses that are in close proximity to the stream because the hydrological pathways are shorter and have fewer obstacles than land uses located away from the riparian corridor. However, during the growing season (i.e. in agricultural return flow) and in storm water runoff, distant land uses can become hydrologically connected to the stream, thus transporting nutrients from the hillslopes to the stream during these time periods.

In addition to agriculture, there are several other human-related activities that influence nutrient concentrations in rivers and streams. Residential areas contribute nutrients from septic tanks, landscape maintenance, as well as backyard livestock (e.g. cattle, horses) and pet wastes. Urban development contributes nutrients by disturbing the land and consequently increasing soil erosion, by increasing the impervious area within the watershed, and by directly applying nutrients to the landscape. Recreational activities such as hiking and biking can also contribute nutrients to the stream by reducing plant cover and increasing soil erosion (e.g. trail network, streambank destabilization), direct application of human waste, campfires and/or wildfires, and dumping trash near the riparian corridor.

Undeveloped, or natural, landscapes also can deliver nutrients to a waterbody through decaying plant material, soil erosion, and wild animal waste. Another geographically occurring nutrient source is atmospheric deposition, which adds nutrients directly to the waterbody through dryfall and rainfall. Atmospheric phosphorus and nitrogen can be found in both organic and inorganic particles, such as pollen and dust. The contributions from these natural sources are generally considered to represent background levels.

Water pollution caused by on-site septic systems is a widespread problem in New Mexico (McQuillan 2004). Septic system effluents have contaminated more water supply wells, and more acre-feet of ground water, than all other sources in the state combined. Groundwater contaminated by septic system effluent can discharge into streams gaining from groundwater inflow. Nutrients such as phosphorous and nitrogen released into gaining streams from aquifers contaminated by septic systems can contribute to eutrophic conditions.

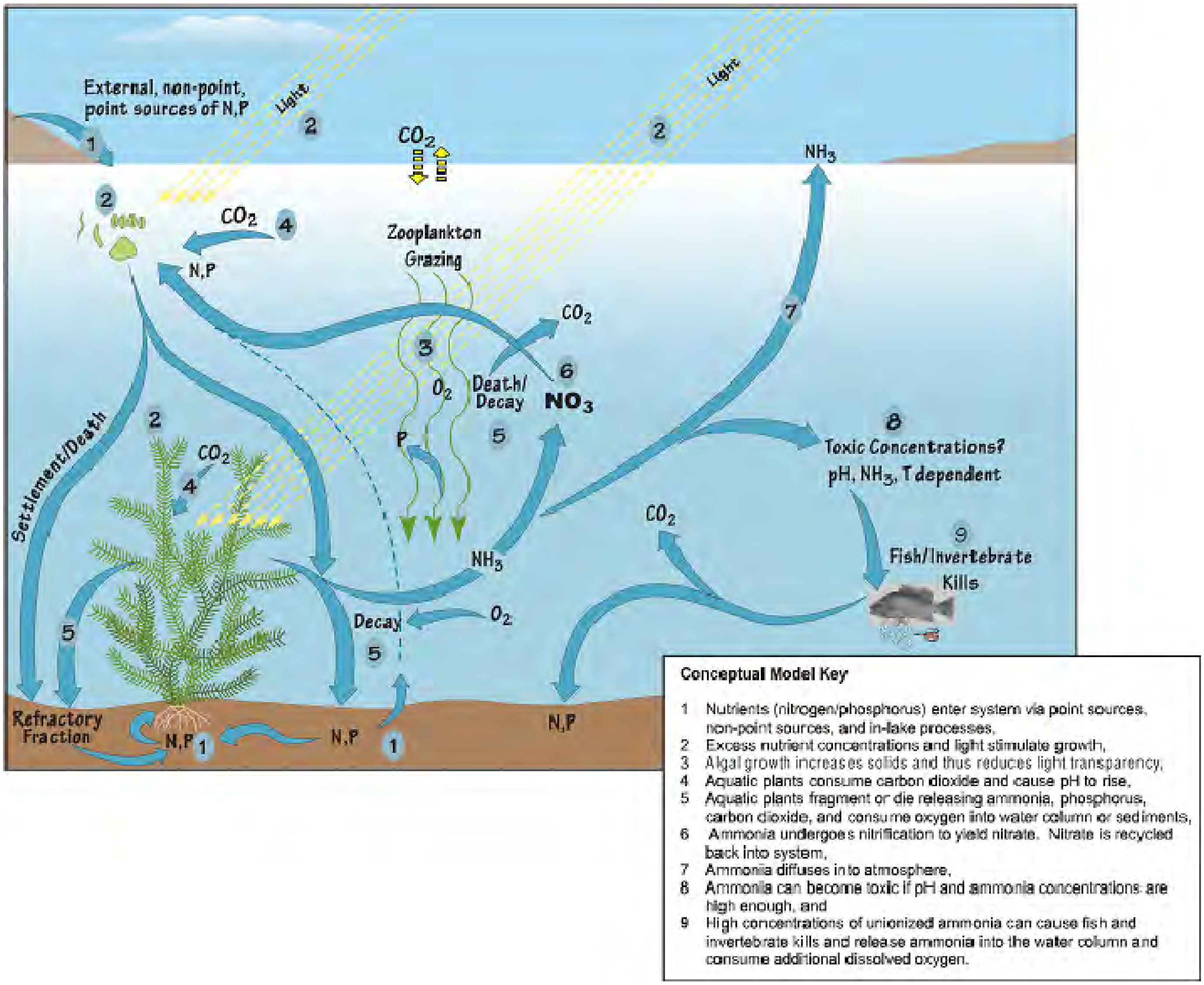


Figure 4.2 Nutrient Conceptual Model (USEPA 1999)

4.7 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. The MOS can be expressed either implicitly or explicitly. An implicit MOS is incorporated by making conservative assumptions in the TMDL analysis, such as allocating a conservative load to background sources. An explicit MOS is applied by reserving a portion of the TMDL and not allocating it to any other sources.

For these nutrient TMDLs, the margin of safety was developed using a combination of conservative assumptions and explicit recognition of potential errors. Therefore, this margin of safety is the sum of the following two elements:

- *Conservative Assumptions*

  Treating phosphorus and nitrogen as pollutants that do not readily degrade in the environment.

  Using the 4Q3 critical low flow "worst case scenario" to calculate the allowable loads.

  Using the design capacity for calculating the point source loading even though under most conditions the treatment plants do not discharge continuously and are not operating at full capacity.

- *Explicit recognition of potential errors*

  A level of uncertainty exists in water quality sampling. Accordingly, a conservative MOS for this element is **10 percent** of the TMDL.

4.8 Consideration of Seasonal Variability

Section 303(d)(1) of the CWA requires TMDLs to be "established at a level necessary to implement the applicable WQS with seasonal variation." Data used in the calculation of this TMDL were collected during spring, summer, and fall in order to ensure coverage of any potential seasonal variation in the system. Exceedences were observed from March through October, during all seasons, which captured flow alterations related to snowmelt, the growing season, and summer monsoonal rains. The critical condition used for calculating the TMDL was low-flow. Calculations made at the critical low-flow (4Q3), in addition to using other conservative assumptions as described in the previous section on MOS, should be protective of the water quality standards designed to preserve aquatic life in the stream. It was assumed that if critical conditions were met during this time, coverage of any potential seasonal variation would also be met.

4.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Rio Arriba County population is projected to grow by a total of 9.6 percent over the 2005-2035 period. However, as of 2009, the largest incorporated town in the watershed, Chama, had an estimated population of 1,345 people which is up from the 2000 Census population of 1,199.

Nutrient loading in this watershed is due to both point and nonpoint sources. Since future projections indicate that nonpoint sources of nutrients will more than likely increase as the region continues to grow and develop, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

5.0 SPECIFIC CONDUCTANCE

During the 2007 SWQB intensive water quality survey, exceedences of the NM water quality criteria for Specific Conductance (SC) were documented in Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters). The following subsections present the SC TMDL for this impaired assessment unit.

According to the NM WQS (20.6.4.119 NMAC), the standard for SC reads:

In any single sample: specific conductance 500 µmhos/cm or less. . .

5.1 Target Loading Capacity

Target values for these SC TMDLs will be determined based on 1) the presence of numeric criteria, 2) the degree of experience in applying the indicator, and 3) the ability to easily monitor and produce quantifiable and reproducible results. For this TMDL document, target values for SC are based on the reduction in total dissolved solids (TDS) necessary to achieve numeric SC criteria. This TMDL is also consistent with New Mexico's antidegradation policy.

The NM Water Quality Control Commission (WQCC) has adopted a numeric water quality criterion for SC to protect the designated use of High Quality Coldwater Aquatic Life (HQCWAL). The water quality criterion has been set at a level to protect coldwater aquatic life. The HQCWAL use designation requires that a stream have water quality, streambed characteristics, and other attributes of habitat sufficient to protect and maintain HQCWAL. The primary standard leading to an assessment of use impairment is the numeric criteria for SC of 500 µmhos/cm.

5.2 Flow

SC in a stream can vary as a function of flow. As flow decreases, the concentration of total dissolved solids (TDS) can increase, thereby increasing the SC. This TMDL is calculated for at a specific flow.

The flow value used to calculate the TMDL for SC on Canjilon Creek was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the annual lowest 4 consecutive day period discharge that will not fall below that discharge at least every 3 years (Waltemeyer 2002). Low flow was chosen as the critical flow because of the negative effect decreasing, or low, flows have on SC.

It is often necessary to calculate a critical flow for a portion of a watershed where there is no active flow gage. 4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). In this analysis, two regression equations for estimating 4Q3 were developed based on physiographic regions of NM (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5} \ DA^{0.70} \ P_w^{\ 3.58} \ S^{1.35} \qquad \text{(Eq. 5-1)}$$

where,

S = Average basin slope (percent).

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The 4Q3 for Canjilon Creek was estimated using the regression equation for mountainous regions because the mean elevations for these assessment units were above 7,500 feet in elevation (Table 5.1).

Table 5.1 Calculation of 4Q3 Low-Flow Frequencies

Assessment Unit	Average Elevation (ft.)	Drainage Area (mi^2)	Mean winter precipitation (in.)	Average basin slope	4Q3 (cfs)
Canjilon Creek (Abiquiu Rsvr to headwaters)	7877	166	9.38	13.7%	0.54

The 4Q3 value was converted from cubic feet per second (cfs) to units of million gallons per day (mgd) as follows using Equation 5-2. The 4Q3 for Canijon Creek is 0.35 mgd.

$$0.54 \frac{ft^3}{\sec} \times 1{,}728 \frac{in^3}{ft^3} \times 0.004329 \frac{gal}{in^3} \times 86{,}400 \frac{\sec}{day} \times 10^{-6} = 0.35 mgd \qquad \text{(Eq. 5-2)}$$

It is important to remember that the TMDL itself is a value calculated at a defined critical condition, and is calculated as part of planning process designed to achieve water quality standards. Since flows vary throughout the year in these systems, the actual load at any given time will vary based on the changing flow. Management of the load to improve stream water quality should be a goal to be attained. Meeting the calculated TMDL may be a difficult objective.

5.3 Calculations

Specific Conductance (SC) may be used to estimate the total ion concentration of a surface water sample, and is often used as an alternative measure of dissolved solids. In order to calculate a load in pounds per day (lbs/day), Total Dissolved Solids (TDS) is used as a surrogate for SC. The TDS to SC ratio ranges from 0.5 to 0.9 milligrams per liter (mg/L)/microhos per centimeter (μmhos/cm) (American Public Health Association, 1998). Specific correlation should be derived by site, if TDS values are available. TDS values were obtained for one site on Canjilon Creek during the 2007 SWQB sampling season. These values as well as the SC values are located in Table 5.2.

Table 5.2 SC and TDS Measurements from 29Canjil006.2 in 2007

Sample Date	Flow (cfs)	SC (µmhos /cm)	TDS (mg/L)	Site-Specific TDS to SC Ratio
4/4/07	43.4	329	264	0.80
4/25/07	26.8	399	332	0.83
5/14/07	31.59	368	312	0.85
6/20/07	3.47	976*	720	0.74
8/6/07	0.3	1320*	1050	0.80
10/2/07	0.17	1352*	1020	0.75

Note: *WQS exceedence

The TDS to SC ratio value was calculated, and averaged, resulting in a TDS:SC ratio of 0.79.

State WQS to protect the designated HQCWAL use states that SC shall not exceed 500 µmhos/cm. The TDS concentration required to achieve State WQS is defined by Equation 5-3.

$$\text{TDS (mg/L)} \cong \text{SC } (\mu\text{mhos/cm}) \times \text{(ratio)} \qquad \text{(Eq. 5-3)}$$

Using the above mentioned reference ratios and an SC value of 500 µmhos/cm, the TDS concentration required to achieve State WQS is:

$$500\ \mu\text{mhos/cm} \times (0.79) \cong 395 \text{ mg/L of TDS}$$

For the purpose of TMDL development, this TDS translator was used. The TMDL was developed based on simple dilution calculations using 4Q3 flow and the TDS translator above (from **Equation 5-3**). The TMDL calculation includes wasteload allocations (WLAs), load allocations (LAs), and a margin of safety (MOS).

Target loads for TDS are calculated based on the 4Q3 flow, the current WQS, and a conversion factor of 8.34, that is used to convert mg/L units to pounds per day (lbs/day) (see **Appendix A** for conversion factor derivation).

Critical Flow (mgd) x Standard (mg/L) x 8.34 = Target Loading Capacity (Eq. 5-4)

The target load (TMDL) predicted to attain standards was calculated using **Equation 5-4** and is shown in Table 5.3.

Table 5.3 Calculation of Daily Target Load for TDS (SC surrogate)

Assessment Unit	Flow[(a)] (mgd)	TDS Standard[(b)] (mg/L)	Conversion Factor[(c)]	TMDL (lbs/day)
Canjilon Creek (Abiquiu Rsvr to headwaters)	0.35	395	8.34	1153

Notes:
[(a)] Flow is the 4Q3 value calculated on the previous pages converted from cubic feet per second to million gallons per day.
[(b)] TDS is used as a surrogate measure for SC in order to calculate a load in lbs/day.
[(c)] Conversion factor used to convert mg/L to lbs/day (See **Appendix A**).
mgd = Million gallons per day
mg/L = Milligrams per liter
lbs/day = Pounds per day

The measured load was also calculated using **Equation 5-4**. In order to achieve comparability between the target and measured loads, the flow rate used was the same for both calculations. The same conversion factor of 8.34 was used. Results are presented in Table 5.4.

Table 5.4 Calculation of Measured Load for TDS (SC surrogate)

Assessment Unit	Flow[(a)] (mgd)	Field TDS[(b)] (mg/L)	Conversion Factor[(c)]	Measured Load (lbs/day)
Canjilon Creek (Abiquiu Rsvr to headwaters)	0.35	960	8.34	2802

Notes:
[(a)] Flow is the 4Q3 value calculated on the previous pages converted from cubic feet per second to million gallons per day.
[(b)] The field measurement is the arithmetic mean of the SC exceedences, converted to TDS (see Table 5.2)
[(c)] Conversion factor used to convert mg/L to lbs/day (See **Appendix A**).
mgd = Million gallons per day
mg/L = Milligrams per liter
lbs/day = Pounds per day

5.4 Waste Load Allocations and Load Allocations

5.4.1 Waste Load Allocation

There are no active point source dischargers on these AUs. Neither are there any Municipal Separate Storm Sewer System (MS4) storm water permits. However, TDS may be a component of some (primarily construction) storm water discharges so these discharges should be addressed.

Storm water discharges from construction activities are transient because they occur mainly during the construction itself, and then only during storm events. Coverage under the National Pollutant Discharge Elimination System (NPDES) Construction General Permit (CGP) for construction sites greater than one acre requires preparation of a Storm Water Pollution Prevention Plan (SWPPP) that includes identification and control of all pollutants associated with the construction activities to minimize impacts to water quality. The current CGP also includes state-specific requirements to implement site-specific interim and permanent stabilization, managerial, and structural solids, erosion, and sediment control Best Management

Practices (BMPs) and/or other controls. BMPs are designed to prevent to the maximum extent practicable an increase in sediment load to the water body or an increase in a sediment-related parameter, such as total suspended solids, turbidity, siltation, stream bottom deposits, etc. BMPs also include measures to reduce flow velocity during and after construction compared to pre-construction conditions to assure that waste load allocations (WLAs) or applicable water quality standards, including the antidegradation policy, are met. Compliance with a SWPPP that meets the requirements of the CGP is generally assumed to be consistent with this TMDL.

Storm water discharges from active industrial facilities are generally covered under the current NPDES Multi-Sector General Permit (MSGP). This permit also requires preparation of an SWPPP, which includes specific requirements to limit (or eliminate) pollutant loading associated with the industrial activities in order to minimize impacts to water quality. Compliance with a SWPPP that meets the requirements of the MSGP is generally assumed to be consistent with this TMDL.

It is not possible to calculate individual WLAs for facilities covered by these General Permits at this time using available tools. Loads that are in compliance with the General Permits are therefore currently included as part of the load allocation (LA).

5.4.2 Load Allocation

In order to calculate the LA, the WLA and MOS were subtracted from the target capacity (TMDL), as shown below in **Equation 5-5**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 5-5)}$$

Results using a MOS of 20% (as explained in Section 5.7), are presented in Table 5.5.

Table 5.5 Calculation of TMDL for TDS (SC Surrogate)

Assessment Unit	WLA (lbs/day)	LA (lbs/day)	MOS (lbs/day)	TMDL (lbs/day)
Canjilon Creek (Abiquiu Rsvr to headwaters)	0	922	231	1153

Notes:
WLA = Waste load allocation
LA = Load allocation
MOS = Margin of safety
TMDL = Total maximum daily load
lbs/day = Pounds per day

The load reduction that would be necessary to meet the target load was calculated to be the difference between the LA (Table 5.5) and the measured load (Table 5.4), and is shown in Table 5.6.

Table 5.6 Calculation of Load Reduction for TDS (SC Surrogate)

Assessment Unit	Target Load (lbs/day)[a]	Measured Load (lbs/day)	Load Reduction (lbs/day)	Percent Reduction[b]
Canjilon Creek (Abiquiu Rsvr to headwaters)	922	2802	1880	67%

Notes:
lbs/day = Pounds per day
[a]Target Load = WLA + LA
[b]Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100

5.5 Identification and Description of Pollutant Source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying “Probable Sources of Impairment” was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period. Pollutant sources that could contribute to Canjilon Creek are listed in Table 5.7.

Table 5.7 Pollutant Source Summary

Assessment Unit	Pollutant Sources	Magnitude (lbs/day)[a]	Probable Sources (% from each)[b]
Canjilon Creek (Abiquiu Rsvr to headwaters)	Point Source	0	0%
	Nonpoint Source	2802	Agriculture, Flow alternations from water diversions, loss of riparian habitat, steambank modifications/destabilization, *cattle/livestock use, on-site treatment sytems, residences, paved roads, highway/road/bridge runoff, drought-related impacts, wildlife other than waterfowl.*

Notes:
(a) Measured Load (Table 5.4).
(b) From the Integrated CWA 303(d)/305(b) List (NMED/SWQB 2010b). This list of probable sources is based on staff observation and known land use activities in the watershed. These sources are not confirmed nor quantified at this time.
***Italicized* Probable Sources were noted during the 2007 water quality survey.**

5.6 Link Between Water Quality and Pollutant Sources

Total dissolved solids (TDS) refers to the total amount of all inorganic and organic substances – including minerals, salts, metals, anions, and cations – that are dispersed within a volume of water. Higher concentrations of TDS may occur during and after precipitation events. In the United States, elevated TDS has been due to natural environmental features such as mineral springs, carbonate deposits, salt deposits, and silt, the decomposition of leaves and plankton, and the weathering erosion of rocks. Other sources may include stormwater and agricultural runoff, mining operations, industrial wastewater, and sewage.

As noted in Section 5.2, as flow decreases, the concentration of total dissolved solids (TDS) can increase, thereby increasing the SC. Similarly, as flows decline, temperatures have a tendency to increase, thus affecting SC values (Figure 5.1)

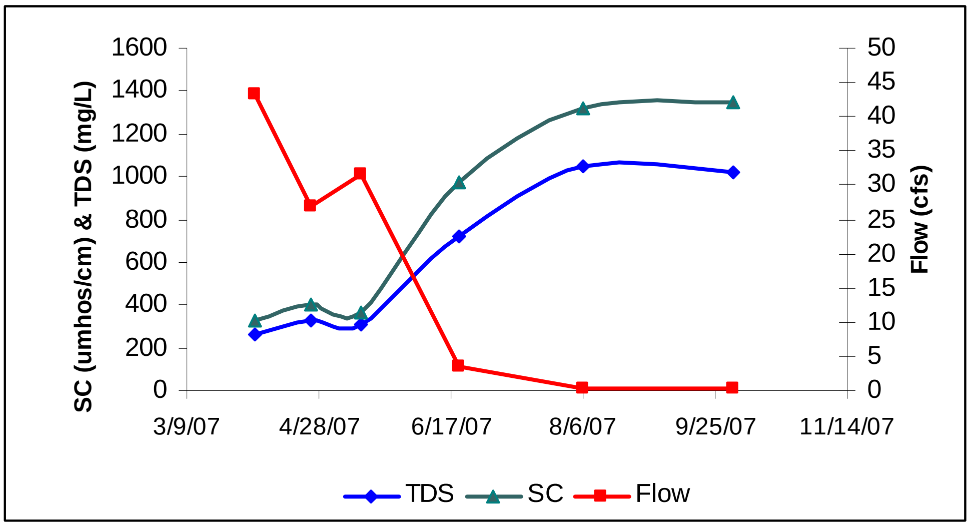


Figure 5.1 Canjilon Creek SC versus flow relationship

The electrical conductivity of water is directly related to the concentration of dissolved solids in the water because TDS concentrations are equal to the sum of positively charged ions (cations) and negatively charged ions (anions) in the water. These electrically charged dissolved particles make ordinary natural water a good conductor of electricity. Conversely, pure water has a high electrical resistance, and resistance is frequently used as a measure of its purity.

Conductivity is measured by SWQB in microsiemens per centimeter (µs/cm). The conductivity of rivers in the United States generally ranges from 50 to 1500 µmhos/cm. Studies of inland fresh waters indicate that streams supporting good mixed fisheries have a range between 150 and 500 µhos/cm. Conductivity outside this range could indicate that the water is not suitable for certain species of fish or macroinvertebrates.

Conductivity in streams and rivers is affected primarily by the geology of the area through which the water flows. Streams that run through areas with granite bedrock tend to have lower conductivity because granite is composed of more inert materials that do not dissolve into ionic components when washed into the water. On the other hand, streams that run through areas with clay soils tend to have higher conductivity because of the presence of materials that ionize when washed into the water. Groundwater inflows can have the same effects depending on the bedrock they flow through. In addition, discharges to streams can change the conductivity depending on their make-up. For example, a failing sewage system would raise the conductivity because of the presence of chloride, phosphate, and nitrate.

Where data gaps exist or the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

The Probable Source Identification Sheets in **Appendix B** provide an approach for a visual analysis of a pollutant source along an impaired reach. Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each impairment. Table 4.13 and Table 4.14 display probable sources of impairment along each reach as determined by field reconnaissance and assessment. Probable sources of nutrients will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

The main sources of impairment along these assessment units appear to be agriculture, flow alterations, loss of riparian habitat, and streambank modifications.

5.7 Margin of Safety

TMDLs should reflect a MOS based on the uncertainty or variability in the data, the point and nonpoint source load estimates, and the modeling analysis. For this TMDL, there is no MOS for point sources, since there are none. However, for the nonpoint sources the MOS for SC is estimated to be an addition of 20 percent of the TMDL. This MOS incorporates several factors:

- Errors in calculating nonpoint source loads

  A level of uncertainty exists in sampling nonpoint sources of pollution. Accordingly, a conservative MOS increases the TMDL by 10 percent.

- Errors in calculating flow

  A 4Q3 flow value for this ungaged stream was estimated based on a regression equation from Waltemeyer (2002). There is inherent error in all flow calculations. A conservative MOS for this element is therefore 10 percent.

5.8 Consideration of Seasonal Variation

Data used in the calculation of this TMDL were collected during high and low flow seasons in order to ensure coverage of any potential seasonal variation in the system. As shown in Table 5.2, exceedences were observed in June, August, and October which are months that capture the summer monsoonal rains and baseflow conditions. There were no measured exceedences during spring runoff. The critical condition used for calculating the TMDL was low flow. Data that exceeded the standard for SC were used in the calculation of the measured loads and can be found in Table 5.2.

5.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Rio Arriba County population is projected to grow by a total of 9.6 percent over the 2005-2035 period. However, as of 2009, the largest incorporated town in the watershed, Chama, had an estimated population of 1,345 people which is up from the 2000 Census population of 1,199.

Estimates of future growth are not anticipated to lead to a significant increase in conductance and/or total dissolved solids that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

6.0 TEMPERATURE

Monitoring for temperature was conducted by SWQB in 2007 and 2010. Based on available data, several exceedences of the New Mexico WQS for temperature were noted throughout the watershed. (Temperature data loggers (thermographs) were set to record once every hour for several months during the warmest time of the year (generally June through August). Thermograph data are assessed using Appendix C of the *State of New Mexico Procedures for Assessing Standards Attainment for the Integrated CWA §303(d)/§305(b) Water Quality Monitoring and Assessment Report [Assessment Protocol]* (NMED/SWQB 2009). Based on 2007 data, temperature listings were added to the *2010-2012 State of NM §303(d) List for Impaired Waters* (NMED/SWQB 2010b) for Rio Chama (El Vado Reservoir to Rio Brazos) and Rio Chama (Little Willow Creek to CO border). Data from 2007 confirmed existing listings for and Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96) and data from 2010 confirmed listings for Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters). The following assessment units have a previous temperature TMDL and were still found to be impaired for temperature based on the assessment of 2007 data: Rio Chama (Rio Brazos to Little Willow Creek) and Rio Chamita (Rio Chama to CO border). A number of other assessment units in the Rio Chama watershed, not addressed in this TMDL document, have existing TMDLs and continued temperature impairments. Temperature data from 2007 and 2010 were used to develop these TMDLs.

6.1 Target Loading Capacity

For this TMDL document, target values for temperature are based on the reduction in solar radiation necessary to achieve numeric criteria as predicted by a temperature model. Three of the four temperature-impaired AUs are classified in 20.6.4.119 NMAC and have the designated use of high quality coldwater aquatic life; the applicable temperature criterion is 20°C (68°F). Rio Puerco de Chama is classified in 20.6.4.118 NMAC with the designated use of coldwater aquatic life and a the segment-specific temperature criterion of 26°C (78.8°F).

SWQB proposed revisions to select temperature criterion during the Triennial Review in December 2009. The revisions are effective as of December 1, 2010 for State purposes and discussed in Section 2.3. The segment-specific temperature criterion in 20.6.4.118 NMAC remains unchanged; temperature 26ºC (78.8ºF). The 2007 WQS defined the temperature criteria for HQCWAL as 20ºC (68ºF) or less whereas the new WQS define the temperature criteria for HQCWAL as 4T3 temperature 20ºC (68ºF), maximum temperature 23ºC (73ºF). Three of the assessment units discussed in this section are classified in 20.6.4.119 NMAC with a designated use of HWCWAL. The definition of 4T3 in the revised WQS reads:

> *"4T3 temperature means the temperature not to be exceeded for four or more consecutive hours in a 24-hour period on more than three consecutive days."*

According to the 2009 Assessment Protocols (NMED/SWQB 2009), an AU is not supporting if

> "*Instantaneous (hourly) temperatures exceed 3.0ºC above the applicable criterion, or temperatures exceed the applicable criterion for four or more consecutive hours in a 24-hour cycle for more than three consecutive days".*

The 2009 Assessment Protocols were used to determine impairment of the waterbodies addressed in this section; thus a maximum temperature of 23ºC (73ºF) and the 4T3 temperature of 20ºC (68ºF) were applied. Although the revised WQS are only effective for State purposes at the time of the development of this document, the assessments and TMDL calculations included in this section will also be protective of the revised WQS.

Table 6.1 highlights the 2007 and 2010 thermograph deployments. This TMDL addresses four reaches where temperatures exceeded the criterion to the extent that a determination of non-support of the applicable designated use was reached.

Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters): One thermograph was deployed on this reach in 2007 above Abiquiu Reservoir at US 84 (29Canjil006.2), but it is noted on the 2010-2012 Integrated List that the thermograph may have been deployed in a non-perennial reach. A thermograph was redeployed in the AU in 2010 at Canjilon Creek above Canjilon (29Canjil039.5). Recorded temperatures from May 26 through August 30 exceeded the HQCW aquatic life use criterion 428 of 2,319 times (18%) with a maximum temperature of 25.9°C on July 18. An air thermograph was deployed at this station during 2007.

Rio Chama (El Vado Reservoir to Rio Brazos): One thermograph was deployed on this reach in 2007 below Rito de Tierra Amarilla above gage 08284100 (29RChama147.0). Recorded temperatures from July 12 through September 18 exceeded the HQCW aquatic life use criterion 735 of 1,626 times (45%) with a maximum temperature of 28.6°C on August 3.

Rio Chama (Little Willow Creek to CO border): One thermograph was deployed on this reach in 2007 at NM 17 (29RChama183.4). Recorded temperatures from June 20 through September 18 exceeded the HQCW aquatic life use criterion 146 of 2,161 times (6.8%) with a maximum temperature of 23.7°C on August 5 and 21.

Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96): One thermograph was deployed on this reach in 2007 at CR 211 (29RPuerc011.0). Recorded temperatures from June 19 through September 17 exceeded the CW aquatic life use criterion 212 of 2,159 times (9.8%) with a maximum temperature of 33.7°C on July 3 and 17.

Table 6.1 Rio Chama watershed thermograph sites (2007, 2010)

STORET ID	Site Name	Deployment Dates (2007, 2010)
29Canjil006.2	Canjilon Creek above Abiquiu Reservoir at US 84 [a]	20 June – 11 July
29Canjil039.5	Canjilon Creek above Canjilon	26 May – 30 Aug
29RCapul010.3	Rio Capulin above Cecilia Canyon Creek	19 June - 17 Sept
29ClearC000.1	Cecilia Canyon Creek at FR 171	19 June - 11 Sept
29RChama183.4	Rio Chama at NM 17	20 June - 18 Sept

STORET ID	Site Name	Deployment Dates (2007, 2010)
29RChama147.0	Rio Chama blw Rito de Tierra Amarilla above 08284100	12 July - 18 Sept
29RChama174.0	Rio Chama below Chama Town	20 June - 18 Sept
29RChami008.3	Rio Chamita at NM 29	15 May - 18 Sept
29RChami002.7	Rio Chamita below Chama WWTP outfall	20 June - 13 Sept
29RGalli045.1	Rio Gallina @ FR 76 [a]	19 June - 17 Sept
29RPuerc011.0	Rio Puerco de Chama at CR 211	19 June – 17 Sept
29RPuerc037.5	Rio Puerco de Chama @ FR 103	19 June – 17 Sept
29RTusas000.1	Rio Tusas above Rio Vallecitos	14 May - 13 Sept
29RResum001.7	Rito Resumidero below Resumidero Spring	14 May - 17 Sept

[a] air thermographs also deployed

6.2 Flow

The critical flow condition for these TMDLs was obtained using a 4-day, 3-year low-flow frequency (4Q3) regression model. The 4Q3 is the minimum average four consecutive day flow that occurs with a frequency of at least once every 3 years. Low flow was chosen as the critical flow because of the negative effect low flows have on temperatures.

When available, USGS gages are used to estimate flow. There were five active gages in the Chama Watershed during the time of the water quality survey and data collection efforts. The 4Q3 flow for Rio Chama (USGS gage 08284100) were estimated using the appropriate gage data and DFLOW software, Version 3.1b (USEPA 2006b). DFLOW 3.1b is a Windows-based tool developed to estimate user selected design stream flows for low flow analysis by utilizing algorithms based on Log Pearson Type III distribution. Waltemeyer (2002) and Thomas *et al*. (1997) were also used.

The specific inflow and outflow values used in the Stream Segment Temperature (SSTEMP) model are discussed in detail in Appendix D.

6.3 Calculations

The SSTEMP Model, Version 2.0, developed by the USGS Biological Resource Division (Bartholow 2002) was used to predict stream temperatures based on watershed geometry, hydrology, and meteorology. The model predicts mean, minimum, and maximum daily water temperatures throughout a stream reach by estimating the heat gained or lost from a parcel of water as it passes through a stream segment (Bartholow 2002). The predicted temperature values are compared to actual thermograph readings measured in the field in order to calibrate the model. The SSTEMP model identifies current stream and/or watershed characteristics that control stream temperatures. The model also quantifies the maximum loading capacity of the stream to meet water quality criteria for temperature. This model is important for estimating the effect of changing controls, or constraints, (such as riparian grazing, stream channel alteration, and reduced streamflow) on stream temperature. The model can also be used to help identify possible implementation activities to improve stream temperature by targeting those factors causing impairment to the stream.

6.4 Waste Load Allocations and Load Allocations

6.4.1 Waste Load Allocation

With the exception of the Rio Chama (El Vado Reservoir to Rio Brazos), there are no point source contributions associated with these TMDLs. No WLA was assigned to the Village of Chama WWTP (NM0027731) in the 1999 temperature TMDL for the Rio Chamita.

The Los Ojos Fish Hatchery (NM0030139) discharges to an unnamed irrigation ditch, Burns Canyon Lake, La Puente Irrigation Ditch, and then the Rio Chama (El Vado Reservoir to Rio Brazos). The Los Ojos Fish Hatchery permit previously contained temperature limitations, but the permit effective September 1, 2006 does not have limitations or monitoring requirements for temperature. Historically, hatchery effluent has not been noted to be a significant contributor of temperature impairment. SWQB has effluent temperature data from January 2004-August 2006 as displayed in Figure 6.1. The highest daily maximum temperature recorded during these 32 months was 15°C during August 2005. None of the recorded readings exceeded the HQCWAL criteria of 20°C. The data indicate that the hatchery is not contributing to elevated temperatures in the AU.

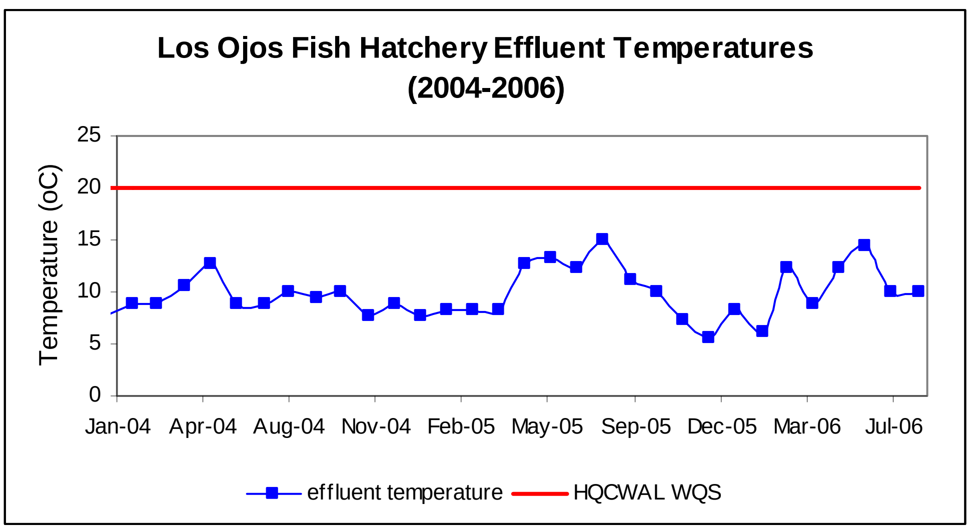


Figure 6.1 Los Ojos Fish Hatchery effluent temperatures (2004-2006)

6.4.2 Load Allocation

Water temperature can be expressed as heat energy per unit volume. SSTEMP provides an estimate of heat energy expressed in joules per square meter per second (j/m^2/s) and Langley's per day. The following information relevant to the model runs used to determine temperature TMDLs is taken from the SSTEMP documentation (Bartholow 2002). Please refer to the SSTEMP User's Manual for complete text. Various notes have been added below in brackets to clarify local sources of input data.

The program will predict the minimum, mean, and maximum daily water temperature for the set of variables you provide (Figure 6.2). The theoretical basis for the model is strongest for the mean daily temperature. The maximum is largely an estimate and likely to vary widely with the maximum daily air temperature. The minimum is computed by subtracting the difference between maximum and mean from the mean; but the minimum is always positive (Bartholow 2002).

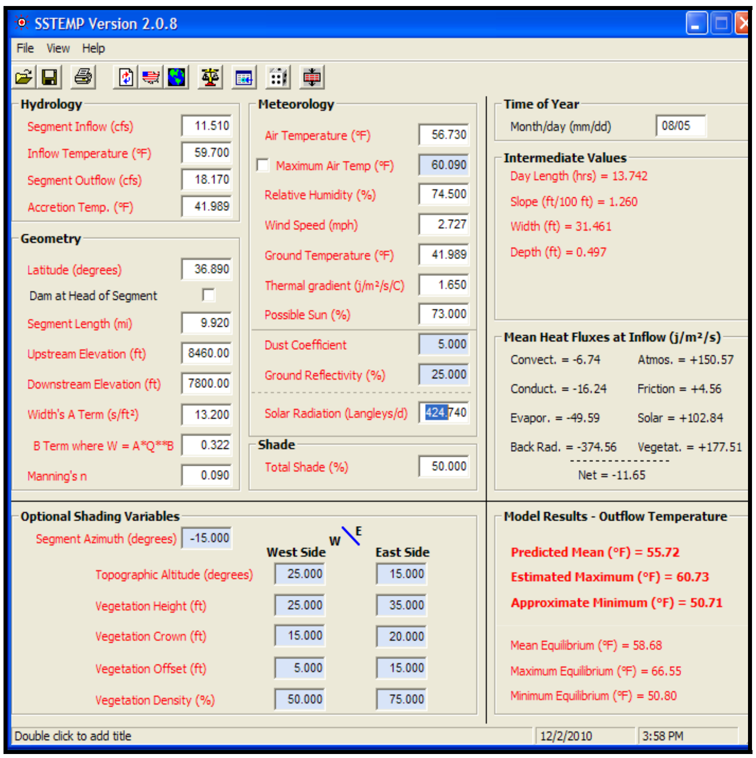


Figure 6.2 Example of SSTEMP input and output for Rio Chama

SSTEMP may be used to compute, one-at-a-time, the sensitivity input values. This simply increases and decreases most active input (i.e., non-grayed out values) by 10% and displays a screen for changes to mean and maximum temperatures. The "Relative Sensitivity" schematic graph that accompanies the display gives an indication of which variables most strongly influence the results (Bartholow 2002). See Figure 6.3 for an example of a sensitivity analysis.

6.4.2.1 Temperature Allocations as Determined by % Total Shade and Width-to-Depth Ratios

Tables 6.2-6.5 detail model outputs for segments on Canjilon Creek, Rio Chama, and Rio Puerco de Chama. SSTEMP was first calibrated against thermograph data to determine the standard error of the model. Initial conditions were determined. As the percent total shade was increased and the Width's A term was decreased, the maximum 24-hour temperature decreased until the segment-specific standard of 20ºC was achieved. The calculated 24-hour solar radiation component is the maximum solar load that can occur in order to meet the WQS (i.e., the target capacity). In order to calculate the actual load allocation (LA), the waste load allocation (WLA) and margin of safety (MOS) were subtracted from the target capacity (TMDL) following **Equation 6-1**.

$$WLA + LA + MOS = TMDL \qquad \text{(Eq. 6-1)}$$

The allocations for each assessment unit requiring a temperature TMDL are provided in the following tables:

<u>Temperature Load Allocation for Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters)</u>

For Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters) the WQS for temperature is achieved when the percent total shade is increased from 54 to 76%. According to the SSTEMP model, the actual LA of 58.14 $j/m^2/s$ is achieved when the shade is further increased to 78.5% (Table 6.2).

Table 6.2 SSTEMP Model Results for Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters)

WQS (HQCW Aquatic Life)	**Model Run Date**	**Segment Length (miles)**	**Solar Radiation Component per 24-Hours (+/-)**	**% Total Shade**	**Modeled Temperature °C (24 hour)**
20°C (68°F)	7/18/10	30.63	**Current Field Condition** +123.81 $j/m^2/s$	54	Minimum: 15.19 Mean: 19.13 Maximum: 23.06
TEMPERATURE ALLOCATIONS FOR Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters) [a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 123.81 $j/m^2/s$ – 58.14 $j/m^2/s$ **= 65.67 $j/m^2/s$**			**Run 1** +107.66 $j/m^2/s$	60	Minimum: 15.02 Mean: 18.64 Maximum: 22.26
			Run 2 +64.60 [a] $j/m^2/s$	76	Minimum: 14.59 Mean: 17.29 Maximum: 20.00
			Actual LA 58.14[b] $j/m^2/s$	78.5	Minimum: 14.53 Mean: 17.08 Maximum: 19.63

Temperature Load Allocation for Rio Chama (El Vado Reservoir to Rio Brazos)

For Rio Chama (El Vado Reservoir to Rio Brazos), the WQS for temperature is achieved when the percent total shade is increased from 9.5 to 49%. According to the SSTEMP model, the actual LA of 104.70 $j/m^2/s$ is achieved when the shade is further increased to 54% (Table 6.3).

Table 6.3 SSTEMP Model Results for Rio Chama (El Vado Reservoir to Rio Brazos)

<table>
<tr><th>WQS
(Coldwater Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours
(+/-)</th><th>% Total Shade</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>20°C
(68°F)</td><td>8/3/07</td><td>14.95</td><td>Current Field Condition
+230.76
$j/m^2/s$</td><td>9.5</td><td>Minimum: 11.83
Mean: 18.44
Maximum: 25.06</td></tr>
<tr><td rowspan="3" colspan="3">TEMPERATURE ALLOCATIONS FOR
Rio Chama (El Vado Reservoir to Rio Brazos)

[a] 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

[b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

230.76 $j/m^2/s$ – 117.04 $j/m^2/s$

= 113.72 $j/m^2/s$</td><td>Run 1
+191.24
$j/m^2/s$</td><td>25</td><td>Minimum: 11.26
Mean: 17.21
Maximum: 23.14</td></tr>
<tr><td>Run 2
+130.04 [a]
$j/m^2/s$</td><td>49</td><td>Minimum: 10.47
Mean: 15.17
Maximum: 19.87</td></tr>
<tr><td>Actual LA
117.04 [b]
$j/m^2/s$</td><td>54</td><td>Minimum: 10.32
Mean: 14.73
Maximum: 19.14</td></tr>
</table>

Temperature Load Allocation for Rio Chama (Little Willow Creek to CO border)

For Rio Chama (Little Willow Creek to CO border), the WQS for temperature is achieved when the percent total shade is increased from 33 to 44%. According to the SSTEMP model, the actual LA of 103.66 $j/m^2/s$ is achieved when the shade is further increased to 50% (Table 6.4).

Table 6.4 SSTEMP Model Results for Rio Chama (Little Willow Creek to CO border)

<table>
<tr><th>WQS (Coldwater Aquatic Life)</th><th>Model Run Date</th><th>Segment Length (miles)</th><th>Solar Radiation Component per 24-Hours (+/-)</th><th>% Total Shade</th><th>Modeled Temperature °C (24 hour)</th></tr>
<tr><td>20°C (68°F)</td><td>8/5/07</td><td>9.92</td><td>Current Field Condition
+137.81 j/m²/s</td><td>33</td><td>Minimum: 10.82
Mean: 16.09
Maximum: 21.36</td></tr>
<tr><td colspan="3" rowspan="3">TEMPERATURE ALLOCATIONS FOR
Rio Chama (Little Willow Creek to CO border)

(a) 24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE

(b) 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY

Actual reduction in solar radiation necessary to meet surface WQS for temperature:

Current Condition – Load Allocation =

137.81 j/m²/s – 103.66 j/m²/s

= 34.15 j/m²/s</td><td>Run 1
+129.58
j/m²/s</td><td>37</td><td>Minimum: 10.72
Mean: 15.79
Maximum: 20.86</td></tr>
<tr><td>Run 2
+115.18 (a)
j/m²/s</td><td>44</td><td>Minimum: 10.57
Mean: 15.27
Maximum: 19.98</td></tr>
<tr><td>Actual LA

+103.66 (b)
j/m²/s</td><td>50</td><td>Minimum: 10.44
Mean: 14.82
Maximum: 19.19</td></tr>
</table>

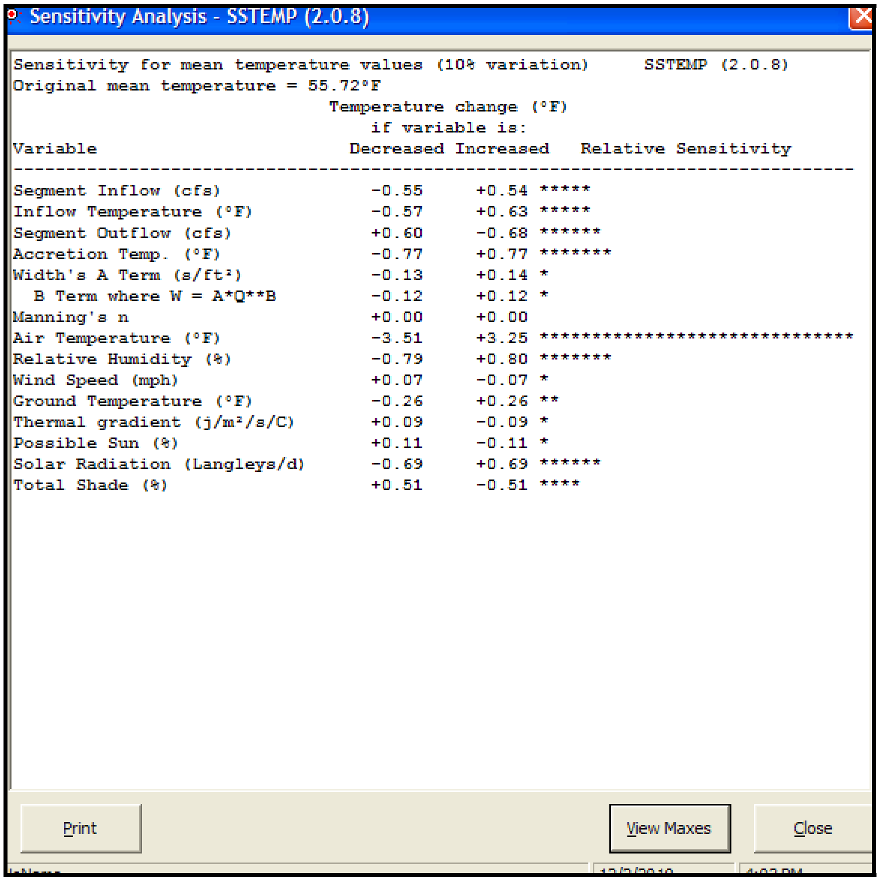
Temperature Load Allocation for Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)

For Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96), the WQS for temperature is achieved when the percent total shade is increased from 10 to 19.5%. According to the SSTEMP model, the actual LA of j/m^2/s is achieved when the shade is further increased to 28% (Table 6.5).

Table 6.5 SSTEMP Model Results for Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)

WQS (Coldwater Aquatic Life)	Model Run Date	Segment Length (miles)	Solar Radiation Component per 24-Hours (+/-)	% Total Shade	Modeled Temperature °C (24 hour)
26°C (78.8°F)	7/3/07	8.81	**Current Field Condition** 262.43 j/m^2/s	10	Minimum: 13.62 Mean: 20.36 Maximum: 27.09
TEMPERATURE ALLOCATIONS FOR Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96) [a] **24-HOUR ACHIEVEMENT OF SURFACE WQS FOR TEMPERATURE** [b] 24-HOUR LOAD ALLOCATION (LA) NEEDED TO ACHIEVE SURFACE WQS WITH A 10% MARGIN OF SAFETY			**Run 1** +247.85 j/m^2/s	15	Minimum: 13.43 Mean: 19.97 Maximum: 26.49
			Run 2 +234.73 [a] j/m^2/s	19.5	Minimum: 13.26 Mean: 19.61 Maximum: 25.95
Actual reduction in solar radiation necessary to meet surface WQS for temperature: Current Condition – Load Allocation = 262.43 j/m^2/s – 211.26 j/m^2/s **=51.17 j/m^2/s**			**Actual LA** 211.26[b] j/m^2/s	28	Minimum: 12.96 Mean: 18.92 Maximum: 24.88

According to the Sensitivity Analysis feature of the model runs (Figure 6.3), mean daily air temperature had the greatest influences on the predicted outflow temperatures and total shade values have the greatest influence on temperature reduction.



Sensitivity for mean temperature values (10% variation)   SSTEMP (2.0.8)
Original mean temperature = 55.72°F

Variable	Temperature change (°F) if variable is: Decreased	Increased	Relative Sensitivity
Segment Inflow (cfs)	-0.55	+0.54	*****
Inflow Temperature (°F)	-0.57	+0.63	*****
Segment Outflow (cfs)	+0.60	-0.68	******
Accretion Temp. (°F)	-0.77	+0.77	*******
Width's A Term (s/ft²)	-0.13	+0.14	*
B Term where W = A*Q**B	-0.12	+0.12	*
Manning's n	+0.00	+0.00	
Air Temperature (°F)	-3.51	+3.25	******************************
Relative Humidity (%)	-0.79	+0.80	*******
Wind Speed (mph)	+0.07	-0.07	*
Ground Temperature (°F)	-0.26	+0.26	**
Thermal gradient (j/m²/s/C)	+0.09	-0.09	*
Possible Sun (%)	+0.11	-0.11	*
Solar Radiation (Langleys/d)	-0.69	+0.69	******
Total Shade (%)	+0.51	-0.51	****

Figure 6.3   Example of SSTEMP sensitivity analysis for Rio Chama

The estimate of total shade used in the model calibration was based on densiometer readings (field notes) and examination of aerial photographs (see **Appendix D**). Target loads as determined by the modeling runs are summarized in Tables 6.2 – 6.5. The MOS is estimated to be 10% of the target load calculated by the modeling runs. Results are summarized in Table 6.6. Additional details on the MOS are presented in Section 6.7 below.

Table 6.6 Calculation of TMDLs for Temperature

Assessment Unit	WLA ($j/m^2/s$)	LA ($j/m^2/s$)	MOS (10%)[a] ($j/m^2/s$)	TMDL ($j/m^2/s$)
Canjilon Creek (perennial portions Abiquiu Resv to hdwtrs)	0	58.14	6.46	64.60
Rio Chama (El Vado Reservoir to Rio Brazos)	0[b]	117.04	13.00	130.04
Rio Chama (Little Willow Creek to CO border)	0	103.66	11.52	115.18
Rio Puerco de Chama (Abiquiu Res to Hwy 96)	0	211.26	23.47	234.73

Notes: [a] Actual MOS values may be slightly greater than 10% because the final MOS is back calculated after the Total Shade value is increased enough to reduce the modeled solar radiation component to a value less than the target load minus 10%.
[b] See discussion in Section 6.4.1.

The load reductions that would be necessary to meet the target loads were calculated to be the difference between the calculated target load and the measured load (i.e., current field condition in Tables 6.2 – 6.5), and are shown in Table 6.7.

Table 6.7 Calculation of Load Reduction for Temperature

Location	Target Load[a] ($j/m^2/s$)	Measured Load ($j/m^2/s$)	Load Reduction ($j/m^2/s$)	Percent Reduction[b]
Canjilon Creek (perennial portions Abiquiu Resv to hdwtrs)	58.14	123.81	65.67	53%
Rio Chama (El Vado Reservoir to Rio Brazos)	117.04	230.76	113.72	49%
Rio Chama (Little Willow Creek to CO border)	103.66	137.81	34.15	25%
Rio Puerco de Chama (Abiquiu Res to Hwy 96)	211.26	262.43	51.17	20%

Notes: The MOS is not included in the load reduction calculations because it is a set aside value which accounts for any uncertainty, or variability, in TMDL calculations and therefore should not be subtracted from the measured load.
(a) Target Load = LA + WLA
(b) Percent reduction is the percent the existing measured load must be reduced to achieve the target load, and is calculated as follows: (Measured Load – Target Load) / Measured Load x 100.

6.5 Identification and Description of pollutant source(s)

SWQB fieldwork includes an assessment of the probable sources of impairment (Appendix B). The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB to include additional input from a variety of stakeholders including landowners, watershed groups, and local, state, tribal and federal agencies. Probable Source Sheets are filled out by SWQB staff during watershed surveys and watershed restoration activities. The draft probable source list will be reviewed and modified, as necessary, with watershed group/ stakeholder input during the TMDL public meeting and comment period.

Table 6.8 Probable source summary for Temperature

Pollutant Sources	Magnitude[a]	Location		Probable Sources[b] (% from each)
Point:				
None	0	--------	0%	
Nonpoint:				
	123.81	Canjilon Creek (perennial portions Abiquiu Resv to hdwtrs)	100%	Agriculture, flow alterations from water diversions, loss of riparian habitat, streambank modifications/destabilization, *cattle/livestock use, on-site treatment sytems, residences, paved roads, highway/road/bridge runoff, drought-related impacts, wildlife other than waterfowl.*
	230.76	Rio Chama (El Vado Reservoir to Rio Brazos)	100%	*Camgrounds, rangeland grazing, bridges/culverts/railroad crossings, roads (paved and gravel) angling pressure, gravel operations, dams/diversions.*
	137.81	Rio Chama (Little Willow Creek to CO border)	100%	*Rangeland grazing, impervious surfaces, residences, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel) angling pressure.*
	262.43	Rio Puerco de Chama (Abiquiu Res to Hwy 96)	100%	Loss of riparian habitat, rangeland grazing, Loss of riparian habitat, rangeland grazing, *cattle/livestock use, landfill, on-site treatment systems, bridges/culverts/railroad crossings, roads (paved, dirt, and gravel),residences, pavement, channelization, incised, mass wasting.*

Notes:
[a] Measured Load as j/m^2/s. Expressed as solar radiation.
[b] From the 2010-2012 Integrated CWA §303(d)/305(b) List
Italicized **Probable Sources were noted during the 2007 water quality survey.**

Although this procedure is subjective, SWQB feels that it provides the best available information for the identification of probable sources of impairment in a watershed. The list of "Probable Sources" is not intended to single out any single land owner or particular land management activity and generally includes several sources for each impairment. Table 6.8 displays pollutant sources that may contribute to each segment as determined by field reconnaissance and evaluation. Probable sources of temperature impairments will be evaluated, refined, and changed as necessary through the Watershed-Based Plan (WBP).

6.6 Linkage of Water Quality and Pollutant Sources

Water temperature influences the metabolism, behavior, and mortality of fish and other aquatic organisms. Natural temperatures of a waterbody fluctuate daily and seasonally. These natural fluctuations do not eliminate indigenous populations, but may affect existing community structure and geographical distribution of species. In fact, such temperature cycles are often necessary to induce reproductive cycles and may regulate other aspects of life history (Mount 1969). Behnke and Zarn (1976) in a discussion of temperature requirements for endangered western native trout recognized that populations cannot persist in waters where maximum temperatures consistently exceed 21-22°C, but they may survive brief daily periods of higher temperatures (25.5-26.7°C). Anthropogenic impacts can lead to modifications of these natural temperature cycles, often leading to deleterious impacts on the fishery. Such modifications may contribute to changes in geographical distribution of species and their ability to persist in the presence of introduced species. Of all the environmental factors affecting aquatic organisms in a waterbody, temperature is always a factor. Heat, which is a quantitative measure of energy of molecular motion that is dependent on the mass of an object or body of water is fundamentally different than temperature, which is a measure (unrelated to mass) of energy intensity. Organisms respond to temperature, not heat.

Temperature increases, as observed in SWQB thermograph data, show temperatures that exceed the State Standards for the protection of aquatic habitat, namely the HQCW and CW aquatic life designated uses. Through monitoring, and pollutant source documentation, it has been observed that the most probable cause for these temperature exceedences are due to the alteration of the stream's hydrograph, removal of riparian vegetation, livestock grazing, and natural causes such as geothermal inputs. Alterations can be historical or current in nature.

A variety of factors impact stream temperature (Figure 6.4). Decreased effective shade levels result from reduction of riparian vegetation. When canopy densities are compromised, thermal loading increases in response to the increase in incident solar radiation. Likewise, it is well documented that many past hydromodification activities have lead to channel widening. Wider stream channels also increase the stream surface area exposed to sunlight and heat transfer. Riparian area and channel morphology disturbances are attributed to past and to some extent current rangeland grazing practices that have resulted in reduction of riparian vegetation and streambank destabilization. These nonpoint sources of pollution primarily affect the water temperature through increased solar loading by: (1) increasing stream surface solar radiation and (2) increasing stream surface area exposed to solar radiation.

Riparian vegetation, stream morphology, hydrology, climate, geographic location, and aspect influence stream temperature. Although climate, geographic location, and aspect are outside of human control, the condition of the riparian area, channel morphology and hydrology can be affected by land use activities. Specifically, the elevated summertime stream temperatures attributable to anthropogenic causes in the Cimarron basin result from the following conditions:

1. Channel widening (i.e., increased width to depth ratios) that has increased the stream surface area exposed to incident solar radiation,

2. Riparian vegetation disturbance that has reduced stream surface shading, riparian vegetation height and density, and
3. Reduced summertime base flows that result from instream withdrawals and/or inadequate riparian vegetation. Base flows are maintained with a functioning riparian system so that loss of a functioning riparian system may lower and sometimes eliminate baseflows. Although removal of upland vegetation has been shown, in some cases, to increase water yield, studies show that removal of riparian vegetation along the stream channel subjects the water surface and adjacent soil surfaces to wind and solar radiation, partially offsetting the reduction in transpiration with evaporation. In losing stream reaches, increased temperatures can result in increased streambed infiltration, which can result in lower base flow (Constantz et al. 1994).

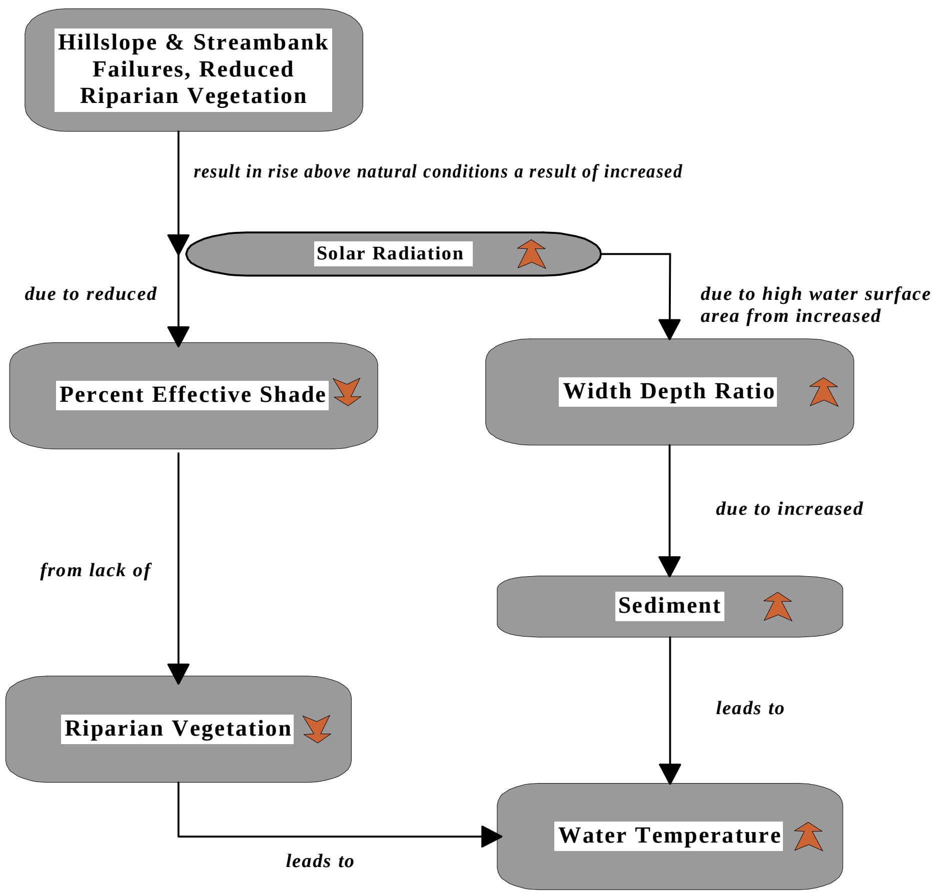


Figure 6.4 Factors That Impact Water Temperature

Through monitoring and pollutant source documentation (Table 6.8) it has been observed that the most probable causes for these temperature exceedences are due to alteration of the stream's hydrograph, removal of riparian vegetation, and natural causes such as geothermal inputs. Alterations can be historical or current in nature.

Analyses presented in these TMDLs demonstrate that the target loading capacities will result in attainment of New Mexico WQS. Specifically, the relationship between shade and water temperature was demonstrated. Vegetation density increases will provide necessary shading, as well as encourage bank-building processes in severe hydrologic events. However, the presentation of percent total shade in Tables 6.2 – 6.5 is only one avenue which may be pursued to decrease water temperature and ultimately meet WQS. Changes in geomorphological parameters might also prove useful. SWQB encourages stakeholders to pursue whichever options seem to be the best fit for each particular watershed or project with the ultimate goal being that the stream temperature meets the WQS.

Where available data are incomplete or where the level of uncertainty in the characterization of sources is large, the recommended approach to TMDL assignments requires the development of allocations based on estimates utilizing the best available information.

6.7 Margin of Safety (MOS)

The CWA requires that each TMDL be calculated with a MOS. This statutory requirement that TMDLs incorporate a MOS is intended to account for uncertainty in available data or in the actual effect controls will have on loading reductions and receiving water quality. A MOS may be expressed as unallocated assimilative capacity or conservative analytical assumptions used in establishing the TMDL (e.g., derivation of numeric targets, modeling assumptions or effectiveness of proposed management actions). The MOS may be implicit, utilizing conservative assumptions for calculation of the loading capacity, WLAs, and LAs. The MOS may also be explicitly stated as an added separate quantity in the TMDL calculation.

For this TMDL, there were no MOS adjustments for point sources since there are none.

In order to develop this temperature TMDL, the following conservative assumptions were used to parameterize the model:

- Data from the warmest time of the year were used in order to capture the seasonality of temperature exceedences.
- Critical upstream and downstream low flows were used because assimilative capacity of the stream to absorb and disperse solar heat is decreased during these flow conditions.
- Low flow was modeled using formulas developed by the USGS. One formula (Thomas et al. 1997) is recommended when the ratio between the gaged watershed area and the ungaged watershed area is between 0.5 and 1.5. When the ratio is outside of this range, a different regression formula is used (Waltemeyer 2002). See **Appendix D** for details.

As detailed in **Appendix D,** a variety of hydrologic, geomorphologic, and meteorological data were used to parameterize the SSTEMP model. Because of the quality of data and information that was put into this model and the continuous field monitoring data used to verify these model outputs, an explicit MOS of 10% is assigned to this TMDL.

6.8 Consideration of seasonal variation

Section 303(d)(1) of the CWA requires TMDLs to be "…established at a level necessary to implement the applicable WQS with seasonal variations". Both stream temperature and flow vary seasonally and from year to year. Water temperatures are coolest in winter and early spring months.

Thermograph records show that temperatures exceed State of New Mexico WQS in summer and early fall. Warmest stream temperatures corresponded to prolonged solar radiation exposure, warmer air temperature, and low flow conditions. These conditions occur during late summer and early fall and promote the warmest seasonal instream temperatures. It is assumed that if critical conditions are met, coverage of any potential seasonal variation will also be met.

6.9 Future Growth

Growth estimates by county are available from the New Mexico Bureau of Business and Economic Research. These estimates project growth to the year 2035. Rio Arriba County population is projected to grow by a total of 9.6 percent over the 2005-2035 period. However, as of 2009, the largest incorporated town in the watershed, Chama, had an estimated population of 1,345 people which is up from the 2000 Census population of 1,199.

Estimates of future growth are not anticipated to lead to a significant increase in water temperature that cannot be controlled with best management practices (BMPs) in this watershed. However, it is imperative that BMPs continue to be utilized in this watershed to improve road conditions and grazing allotments and adhere to SWPPP requirements related to construction and industrial activities covered under the general permit.

7.0 MONITORING PLAN

Pursuant to CWA Section 106(e)(1), the SWQB has established appropriate monitoring methods, systems and procedures in order to compile and analyze data on the quality of the surface waters of New Mexico. In accordance with the New Mexico Water Quality Act, the SWQB has developed and implements a comprehensive water quality monitoring strategy for the surface waters of the State.

The monitoring strategy establishes the methods of identifying and prioritizing water quality data needs, specifies procedures for acquiring and managing water quality data, and describes how these data are used to progress toward three basic monitoring objectives: to develop water quality-based controls, to evaluate the effectiveness of such controls, and to conduct water quality assessments. SWQB revised its 10-year monitoring and assessment strategy (NMED/SWQB 2010a) and submitted it to EPA Region 6 for review on March 23, 2010. The strategy details both the extent of monitoring that can be accomplished with existing resources plus expanded monitoring strategies that could be implemented given additional resources. According to the watershed rotation described in the strategy, the next time SWQB will conduct a water quality survey in the Rio Chama watershed is 2012.

The SWQB utilizes a rotating basin system approach to water quality monitoring. In this system, a select number of watersheds are intensively monitored each year with an established return frequency of approximately every eight years. The next scheduled monitoring date for the Rio Chama Watershed is 2012. The SWQB maintains current quality assurance and quality control plans to cover all monitoring activities. This document, called the QAPP, is updated and certified annually by USEPA Region 6. In addition, the SWQB identifies the data quality objectives required to provide information of sufficient quality to meet the established goals of the program. Current priorities for monitoring in the SWQB are driven by the CWA Section 303(d) list of streams requiring TMDLs. Short-term efforts were directed toward those waters that are on the USEPA TMDL consent decree list (U.S. District Court for the District of New Mexico 1997), however NMED/SWQB completed the final remaining TMDL on the consent decree in December 2006 and USEPA approved this TMDL in August 2007. The U.S. District Court dismissed the Consent Decree on April 21, 2009.

Once assessment monitoring is completed, those reaches showing impacts and requiring a TMDL will be targeted for more intensive monitoring. The methods of data acquisition include fixed-station monitoring, intensive surveys of priority assessment units (including biological assessments), and compliance monitoring of industrial, federal, and municipal dischargers, as specified in the SWQB Standard Operating Procedures (NMED/SWQB 2007).

Long-term monitoring for assessments will be accomplished through the establishment of sampling sites that are representative of the waterbody and which can be revisited approximately every seven years. This information will provide time relevant information for use in CWA Section 303(d) listing and 305(b) report assessments and to support the need for developing TMDLs. The approach provides:

- a systematic, detailed review of water quality data which allows for a more efficient use of valuable monitoring resources;
- information at a scale where implementation of corrective activities is feasible;
- an established order of rotation and predictable sampling in each basin which allows for enhanced coordinated efforts with other programs; and
- program efficiency and improvements in the basis for management decisions.

It should be noted that a watershed would not be ignored during the years in between water quality surveys. The rotating basin program will be supplemented with other data collection efforts such as the funding of long-term USGS water quality gaging stations for long-term trend data and on-going studies being performed by the USGS and USEPA. Data will be analyzed and field studies will be conducted to further characterize acknowledged problems and TMDLs will be developed and implemented accordingly. Both long-term and intensive field studies can contribute to the State's Integrated §303(d)/§305(b) listing process for waters requiring TMDLs.

8.0 IMPLEMENTATION OF TMDLS

8.1 Point Sources – NPDES Permitting

Specific permit implementation discussions for *E.coli* and temperature are included in Sections 3.4.1 and 6.4.1. However, a more detailed discussion of nutrient TMDL implementation strategies is discussed below.

Los Ojos State Fish Hatchery and the Village of Chama WWTP discharge to their respective receiving waters under authorization of an NPDES permit, but the facilities are currently not designed to treat effluent for total phosphorus and total nitrogen. Federal regulations (40 CFR 130.12(a) and 40 CFR 122.44(d)(1)(vii)) clearly require that NPDES permits must be consistent with the wasteload allocation (WLA) of an adopted and approved TMDL. These facilities may need to develop and implement treatment to meet the new effluent requirements that will result from this TMDL. It is the policy of the WQCC to allow schedules of compliance in NPDES permits on a case-by-case basis where facility modifications need to be made to meet new water quality based requirements (20.6.4.12 NMAC).

Los Ojos State Fish Hatchery (NM0030139)

Los Ojos Fish Hatchery discharges into an unnamed irrigation ditch, thence to Upper Burns Lake / Burns Canyon Lake, thence to La Puente Irrigation Ditch, thence to the Rio Chama in segment 20.6.4.119 NMAC. Since limited nutrient data were available from the hatchery to determine actual effluent concentrations (see Section 4.4.1), SWQB is recommending preliminary (Phase 1) effluent limits of 0.24 mg/L and 3.0 mg/L for TP and TN, respectively, when the NPDES permit is up for renewal. The TP limit was calculated by allocating 85% of the TMDL to the wasteload allocation. The TN limit is based on the annual average concentration for the limit of technology. Monitoring requirements for nutrients should be outlined in the new permit to gather baseline data, to determine the actual nutrient load from the hatchery, and to document the actual load reaching the Rio Chama. Any variation from preliminary levels that leads to excess nutrients entering the Rio Chama should result in more stringent effluent limits when the NPDES permit is up for renewal. The next tentatively scheduled water quality monitoring for the Rio Chama watershed is 2012.

Village of Chama Wastewater Treatment Plant (NM0027731)

The Village of Chama WWTP contributes approximately 89% of the measured nitrogen load and 85% of the measured phosphorus load in Rio Chamita. The current nitrogen loading from the WWTP is approximately 3 times the level that it should be to maintain the chemical and biological integrity of the stream. Additionally, the phosphorus loading from the plant is approximately 4 times the target load defined in this TMDL.

The SWQB used a simple, steady-state mass balance equation to test the mixing potential and dilution capacity of the receiving water under two scenarios: (1) discharge to the Rio Chamita and (2) discharge to the Rio Chama. The mass balance equation takes into consideration current nutrient concentrations in the stream, in-stream target concentrations, as well as flow conditions to estimate effluent concentrations that would be within the assimilative capacity of the stream. Effluent limits calculated under Scenario 1 (discharge to Rio Chamita) were comparable to the annual averages for the limits of technology (3.0 mg/L TN and 0.2 mg/L TP). Effluent limits calculated under Scenario 2 (discharge to the Rio Chama) were equivalent to the in-stream targets identified in Table 4.3 (0.25 mg/L TN and 0.07 mg/L TP), which are technologically unachievable at this time.

The SWQB also took another approach to estimate effluent limits, which was to explicitly allocate a portion of the Target Load (Table 4.7) to the WWTP. Again, two scenarios were reviewed: (1) discharge to the Rio Chamita and (2) discharge to the Rio Chama. Effluent limits allocated under Scenario 1 (discharge to the Rio Chamita) and under Scenario 2 (discharge to the Rio Chama) were relatively similar. Both scenarios assume a required N:P ratio of 10:1 for algal biomass. Based on this analysis, several key points become apparent:

- the in-stream targets for the Rio Chama are much lower than Rio Chamita (Table 4.3),
- the ambient, upstream nutrient concentrations in the Rio Chama are relatively high, and
- there is a substantial load reduction that needs to occur in the Rio Chama in order for the stream to meet its target load.

Discharging to the Rio Chama (Little Willow Creek to the Colorado border) looks as if it will not provide much relief to the Village of Chama WWTP; however, advanced treatment will significantly reduce the load of TN and TP that is introduced to the receiving water whether that water is the Rio Chamita or the Rio Chama.

The preliminary (Phase 1) wasteload allocations and effluent limits outlined in Section 4.4.1 (Table 4.9) are assuming that the Village of Chama will continue to discharge to the Rio Chamita. If the Village decides that it is in their best interest to move the discharge to the Rio Chama then the TMDL and NPDES permit will need to be revised to accommodate this change and new wasteload allocations and effluent limits will be assigned.

Seasonal Option

Biological treatment is highly temperature dependent therefore the new NPDES permits may need to consider seasonal targets based on the facility's design. Below is an example of a possible seasonal component that could be incorporated into the new permits:

From October 1 through April 30 each year, when in-stream biological activity is generally at its lowest due to lower temperatures and shorter periods of daylight, the effluent limits would be technology-based limits. Although these effluent limits are relatively high and substantially higher than the in-stream target concentrations in this TMDL, they would reduce the loading from the facility by roughly half during these months.

- TP = 1.0 mg/L (30-day average), 1.5 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks
- TN = 10.0 mg/L (30-day average), 15.0 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks

From May 1 through September 30 each year, when in-stream biological activity is generally at its highest due to higher temperatures and longer periods of daylight, the effluent limits would be based on the Phase 1 limits in this TMDL. Although these effluent limits are considerably higher than the in-stream target concentrations in this TMDL, they would reduce the loading from the facility by roughly 80% during these months.

- TP = 0.4 mg/L (30-day average), 0.6 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks

- TN = 4.0 mg/L (30-day average), 6.0 mg/L (daily max) measured by 3-hour composite, not less than once per two weeks
- **It should be noted that these are only recommendations. The final determination of permit language and seasonality will be up to EPA Region 6 and NMED NPDES staff.**

These seasonal effluent limits would significantly reduce the loads of TP and TN that are introduced into the receiving stream. After implementation of these technology-based limits and seasonal discharge regimes and given enough time to allow the aquatic system to respond, NMED would then reevaluate the condition of the stream and the nutrient TMDL. The next scheduled water quality survey for the larger Rio Chama watershed is 2012. At the time that NMED reevaluates the conditions in the stream, if it is found to still be impaired for nutrients and the new facility is operational, the WWTP would be required to increase the treatment of the effluent by adding tertiary treatment or find another means of disposal (Figure 4.1).

8.2 Nonpoint Sources – WBP and BMP Coordination

Public awareness and involvement will be crucial to the successful implementation of these plans and improved water quality. Staff from SWQB will work with stakeholders to provide guidance in developing Watershed-Based Plans (WBPs) for each impaired stream segment for which a TMDL has been prepared. A WBP is a written plan intended to provide a long-range vision for various activities and management of resources in a watershed. It describes opportunities for private landowners and public agencies to reduce and prevent nonpoint source impacts to water quality. These long-range strategies will become instrumental in coordinating efforts to achieve water quality standards in the watershed. A WBP is essentially an Implementation Plan, or Phase Two of the TMDL process. The completion of the TMDLs and WBPs leads to the development of on-the-ground projects to address surface water impairments in the watershed.

NMED conducts an annual request for proposals to identify watershed-based planning projects for support with incremental funds appropriated by Congress under Section 319(h) of the Clean Water Act. These projects develop WBPs which meet the planning elements identified by EPA in the *Nonpoint Source Program and Grants Guidelines for States and Territories* (Fed. Reg., October 23, 2003). During the watershed-based planning process, SWQB staff provides technical support related to monitoring, pollutant source identification, selection and application of BMPs, and other aspects of the planning elements. Stakeholder public outreach and involvement in the implementation of this TMDL will be ongoing. Stakeholder involvement is a key aspect of the watershed-based planning process.

WBPs describe work which could be implemented under various programs and organizations with authority or responsibility related to water quality. Section 319 funding is one source of such funding. NMED conducts a second annual request for proposals for projects which implement components of WBPs.

Section 319 funds made available through the requests for proposals are available on a competitive basis to all private, for-profit and nonprofit organizations that are authenticated legal entities, or governmental jurisdictions including: cities, counties, tribal entities, Federal agencies, or agencies of the State. Funded projects require a non-federal match of 40% of the total project cost, consisting of funds and/or in-kind services. Further information on funding from the CWA §319 (h) can be found at the SWQB website: http://www.nmenv.state.nm.us/swqb/.

8.3 Time Line

Table 8.1 details a general, proposed implementation timeline.

Table 8.1 Proposed Implementation Timeline

Implementation Actions	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8
Public Outreach and Involvement	X	X	X	X	X	X	X	X
TMDL Development	X	X						
WBP Development				X	X	X		
Revise any NPDES permits as necessary			X					X
Establish Performance Targets				X				
Secure Funding			X	X				
Implement Management Measures (BMPs)			X	X	X	X	X	X
Monitor BMPs			X	X	X			
Determine BMP Effectiveness					X	X	X	X
Re-evaluate Performance Targets						X	X	X

8.4 Other Funding Opportunities and Restoration Efforts in the Rio Chama Basin

Several other sources of funding exist to address impairments discussed in this TMDL document. One of the elements of a watershed-based plan is, “an estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon”, to implement the plan. NMED’s Construction Programs Bureau assists communities in need of funding for WWTP upgrades and improvements to septic tank management. They can also provide matching funds for appropriate CWA §319(h) projects using state revolving fund monies. The USDA Environmental Quality Incentive Program (EQIP) program can provide assistance to agricultural producers in the basin. The USDA Forest Service aligns their mission to protect lands they manage with the TMDL process, and are another source of assistance. The BLM has several programs in place to provide assistance to improve unpaved roads and grazing allotments.

9.0 APPLICABLE REGULATIONS and STAKEHOLDER ASSURANCES

New Mexico's Water Quality Act (Act) authorizes the WQCC to "promulgate and publish regulation to prevent or abate water pollution in the state" and to require permits. The Act authorizes a constituent agency to take enforcement action against any person who violates a water quality standard. Several statutory provisions on nuisance law could also be applied to NPS water pollution. The Water Quality Act also states in §74-6-12(a):

> *The Water Quality Act (this article) does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights.*

In addition, the State of New Mexico Surface Water Quality Standards (see Subsection C of 20.6.4.6 NMAC) (NMAC 2007) states:

> *Pursuant to Subsection A of Section 74-6-12 NMSA 1978, this part does not grant to the water quality control commission or to any other entity the power to take away or modify property rights in water.*

New Mexico policies are in accordance with the federal Clean Water Act §101(g):

> *It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this Act. It is the further policy of Congress that nothing in this Act shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.*

New Mexico's CWA §319 Program has been developed in a coordinated manner with the State's 303(d) process. All 319 watersheds that are targeted in the annual RFP process coincide with the State's biennial impaired waters list as approved by USEPA. Section 319 funds are further prioritized to target impaired waters with developed TMDLs, and a smaller category of impaired waters which do not require TMDLs because the impairment is considered to be related to flow rather than excessive pollutant loading. The State has given a high priority for funding, assessment, and restoration activities to these watersheds.

As a constituent agency, NMED has the authority under Chapter 74, Article 6-10 NMSA 1978 to issue a compliance order or commence civil action in district court for appropriate relief if NMED determines that actions of a "person" (as defined in the Act) have resulted in a violation of a water quality standard including a violation caused by a NPS. The NMED NPS water quality management program has historically strived for and will continue to promote voluntary compliance to NPS water pollution concerns by utilizing a voluntary, cooperative approach. The State provides technical support and grant monies for implementation of BMPs and other NPS prevention mechanisms through §319 of the Clean Water Act. Since portions of this TMDL will be implemented through NPS control mechanisms, the New Mexico Watershed Protection Program will target efforts to this and other watersheds with TMDLs.

In order to obtain reasonable assurances for implementation in watersheds with multiple landowners, including federal, state and private land, NMED has established Memoranda of Understanding (MOUs) with various federal agencies, in particular the Forest Service and the Bureau of Land Management. MOUs have also been developed with other state agencies, such as the New Mexico Department of Transportation. These MOUs provide for coordination and consistency in dealing with NPS issues.

The time required to attain standards for all reaches is estimated to be approximately 10-20 years. This estimate is based on a five-year time frame implementing several watershed projects that may not be starting immediately or may be in response to earlier projects. Stakeholders in this process will include SWQB, and other parties identified in the WBP. The cooperation of watershed stakeholders will be pivotal in the implementation of these TMDLs as well.

10.0 PUBLIC PARTICIPATION

Public participation was solicited in development of this TMDL (see **Appendix E**). The draft TMDL was made available for a 30-day comment period beginning on February 23, 2011. Response to comments will be attached as **Appendix F** to the final draft document. The draft document notice of availability was extensively advertised via newsletters, email distribution lists, webpage postings (http://www.nmenv.state.nm.us), and press releases to area newspapers. A public meeting was held on March 7, 2011 at the Rio Arriba County Courthouse in Tierra Amarilla.

NMED staff from both SWQB and Construction Programs Bureau met with Village and Molzen-Corbin staff on March 23, 2011 in Santa Fe to discuss questions regarding the TMDL and updates about the new WWTP.

Once the TMDL is approved by the Water Quality Control Commission, the next step for public participation in activities as described in Section 8.0 and participation in watershed protection projects including those that may be funded by Clean Water Act Section 319(h) grants.

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APPENDIX A
CONVERSION FACTOR DERIVATION

Flow (as million gallons per day [mgd]) and concentration values (milligrams per liter [mg/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{mg}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-mg}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000\,mg} = 8.34\,\frac{L-lb}{gal-mg}$$

Flow (as million gallons per day [mgd]) and concentration values (micrograms per liter [ug/L]) must be multiplied by a conversion factor in order to express the load in units "pounds per day." The following expressions detail how the conversion factor was determined:

TMDL Calculation:

$$Flow\,(mgd) \times Concentration\left(\frac{ug}{L}\right) \times ConversionFactor\left(\frac{L-lb}{gal-ug}\right) = Load\left(\frac{lb}{day}\right)$$

Conversion Factor (CF) Derivation:

$$CF = 10^6 \times \frac{3.785\,L}{gal} \times \frac{1\,lb}{454{,}000{,}000\,ug} = 0.00834\,\frac{L-lb}{gal-ug}$$

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APPENDIX B
PROBABLE SOURCES OF IMPAIRMENT

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"Sources" are defined as activities that may contribute pollutants or stressors to a water body (USEPA 1997). The list of "Probable Sources of Impairment" in the Integrated 303(d)/305(b) List, Total Maximum Daily Load documents (TMDL's), and Watershed-Based Plans (WBP's) is intended to include any and all activities that could be contributing to the identified cause of impairment. Data on Probable Sources is routinely gathered by Monitoring and Assessment Section staff and Watershed Protection Section staff during water quality surveys and watershed restoration projects and is housed in the Assessment Database (ADB version 2). ADB was developed by USEPA to help states manage information on surface water impairment and to generate §303(d)/ §305(b) reports and statistics. More specific information on Probable Sources of Impairment is provided in individual watershed planning documents (e.g., TMDL's, WBP's, etc) as they are prepared to address individual impairments by assessment unit.

USEPA through guidance documents strongly encourages states to include a list of Probable Sources for each listed impairment. According to the 1998 305(b) report guidance, "…, states must always provide aggregate source category totals…" in the biennial submittal that fulfills CWA section 305(b)(1)(C) through (E) (USEPA 1997). The list of "Probable Sources" is not intended to single out any particular land owner or single land management activity and has therefore been labeled "Probable" and generally includes several sources for each known impairment.

The approach for identifying "Probable Sources of Impairment" was recently modified by SWQB. Any new impairment listing will be assigned a Probable Source of "Source Unknown." Probable Source Sheets will continue to be filled out during watershed surveys and watershed restoration activities by SWQB staff. Information gathered from the Probable Source Sheets will be used to generate a draft Probable Source list in consequent TMDL planning documents. These draft Probable Source lists will be finalized with watershed group/stakeholder input during the pre-survey public meeting, TMDL public meeting, WBP development, and various public comment periods. The final Probable Source list in the approved TMDL will be used to update the subsequent Integrated List.

Literature Cited:

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Figure B1. Probable Source Development Process and Public Particpation Flowchart

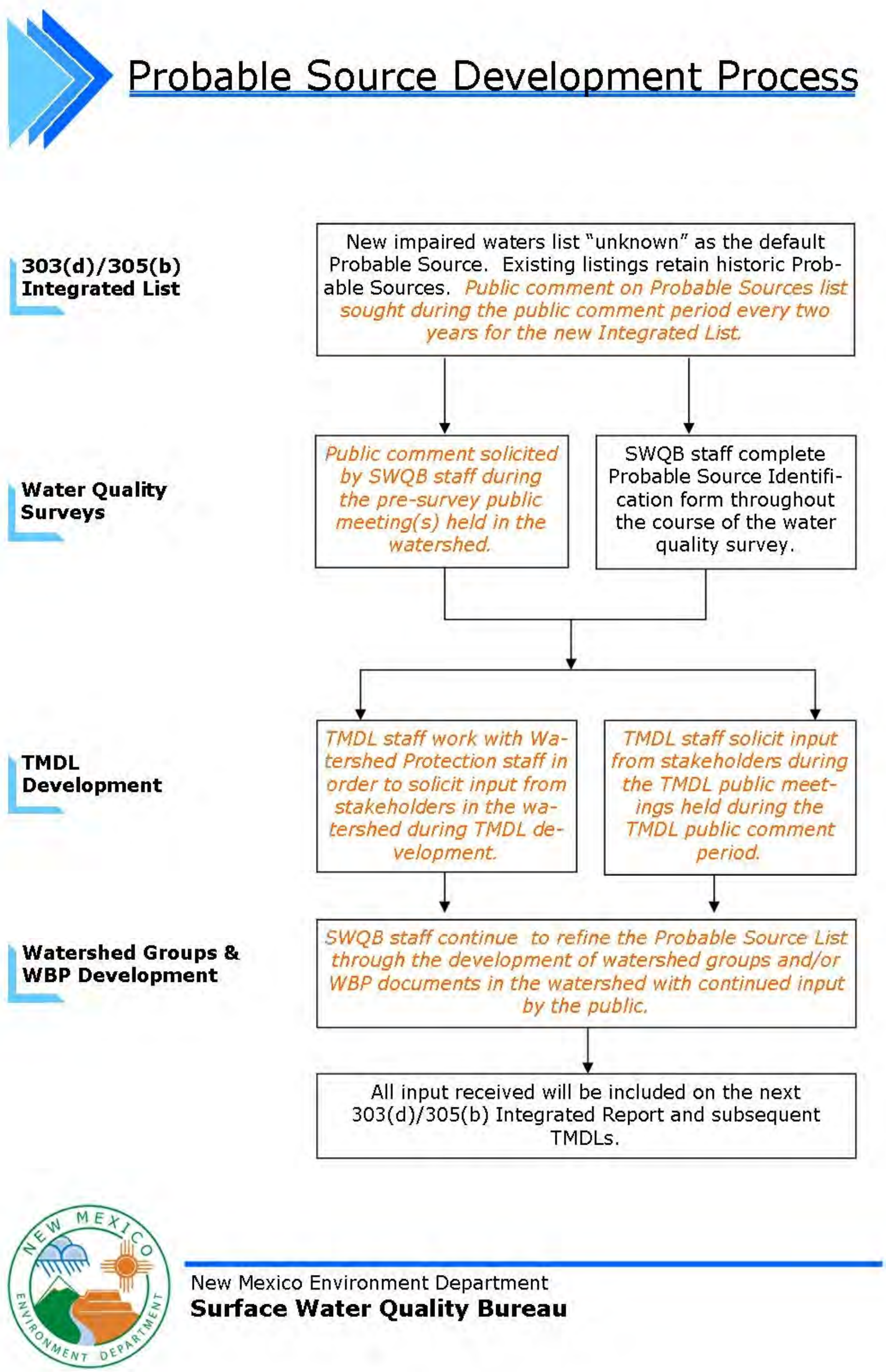

Figure B2. Probable Source Identification Sheet for the Public

Help Us Identify Probable Sources of Impairment

Name:
Phone Number (optional):
Email or Mailing Address (optional):
Date:
Waterbody Name/ Watershed Name/ Location of concern:

From the list below, please check the items you believe are sources of water quality impairment in the watershed or waterbody of concern. In the spaces next to each item you check, please use the following scale to indicate how much of a concern that item is to you by specifying a number between 1 and 3.

(1 - Slight Concern) (2 – Moderate Concern) (3 – High Concern)

✓	ACTIVITY	Scale of Concern			✓	ACTIVITY	Scale of Concern		
☐	Feedlots	1	2	3	☐	Pavement and Other Impervious Surfaces	1	2	3
☐	Livestock Grazing	1	2	3	☐	Roads/Bridges/Culverts	1	2	3
☐	Agriculture	1	2	3	☐	Habitat Modification(s)	1	2	3
☐	Flow Alterations (water withdrawal)	1	2	3	☐	Mining/Resource Extraction	1	2	3
☐	Stream/River Modification(s)	1	2	3	☐	Logging/Forestry Operations	1	2	3
☐	Storm Water Runoff	1	2	3	☐	Housing or Land Development	1	2	3
☐	Flooding	1	2	3	☐	Exotic species	1	2	3
☐	Landfill(s)	1	2	3	☐	Waterfowl	1	2	3
☐	Industry/Wastewater Treatment Plant	1	2	3	☐	Wildlife and domesticated animals other than waterfowl	1	2	3
☐	Inappropriate Waste Disposal	1	2	3	☐	Recreational Use	1	2	3
☐	Improperly maintained Septic Systems	1	2	3	☐	Natural Disturbances *(please describe)*	1	2	3
☐	Other: *(please describe)*	1	2	3	☐	Other: *(please describe)*	1	2	3

Comments:

Figure B3. Probable Source Identification Sheet for NMED and Other Agencies

16 Mar 09
Ver. 2

Probable Source Field Sheet & Site Condition Class Verification

Station ID:	Station Name/Description:
Field Crew:	Comments:
Date:	Watershed protection staff reviewer: Date of WPS review:
WQS Segment from 20.6.4 NMAC:	Assessment Unit:

Score the proximity and certainty of occurance of the following activities in the watershed upstream of the site. Consult with the appropriate staff at NMED and other agencies to score shaded cells. Fill out after recon during 1st or 2nd site visit, review and revise at the end of the survey, and have it reviewed by Watershed Protection Staff with knowledge of the particular watershed. Maintain completed forms in Survey Binder.

Activity Checklist

Agriculture				
Permitted CAFOs	0	1	3	5
Crop Production (Cropland or Dry Land)	0	1	3	5
Drains	0	1	3	5
Irrigated Crop Production (Irrigation Equip)	0	1	3	5
Permitted Aquaculture	0	1	3	5
Other:	0	1	3	5

Rangeland				
Livestock Grazing or Feeding Operation	0	1	3	5
Rangeland Grazing (dispersed)	0	1	3	5
Other:	0	1	3	5

Industrial/ Municipal				
Industrial Stormwater Discharge (permitted)	0	1	3	5
Storm water Runoff due to Construction	0	1	3	5
Industrial Point Source Discharge	0	1	3	5
Landfill	0	1	3	5
Municipal Point Source Discharge	0	1	3	5
On-Site Treatment Systems (Septic, etc.)	0	1	3	5
Pavement/ /Impervious Surfaces	0	1	3	5
Inappropriate Waste Disposal	0	1	3	5
RCRA/Superfund Site	0	1	3	5
Residences/Buildings	0	1	3	5
Site Clearance (Land Development)	0	1	3	5
Urban Runoff/Storm Sewers	0	1	3	5
Power Plants	0	1	3	5
Other:	0	1	3	5

Resource Extraction				
Abandoned Mines (Inactive)/Tailings	0	1	3	5
Acid Mine Drainage	0	1	3	5
Active Mines (Placer/Potash/Other -- circle)	0	1	3	5
Oil/Gas Activities (Permitted/Legacy – circle)	0	1	3	5
Reclamation of Inactive Mines	0	1	3	5
Other:	0	1	3	5

Roads				
Bridges/Culverts/RR Crossings	0	1	3	5
Low Water Crossing	0	1	3	5
Paved Roads	0	1	3	5
Gravel or Dirt Roads	0	1	3	5
Other:	0	1	3	5

Silviculture				
Logging Ops – Active Harvesting	0	1	3	5
Logging Ops – Legacy	0	1	3	5
Fire Suppression (Thinning/Chemicals)	0	1	3	5
Other:	0	1	3	5

Hydromodifications				
Channelization	0	1	3	5
Dams/Diversions	0	1	3	5
Draining/Filling Wetlands	0	1	3	5
Dredging	0	1	3	5
Irrigation Return Drains	0	1	3	5
Riprap/Wall/Dike/Jetty Jack -- circle	0	1	3	5
Flow Alteration (from Water Diversions/Dam Ops – circle)	0	1	3	5
Highway/Road/Bridge Runoff	0	1	3	5
Other:	0	1	3	5

Miscellaneous				
Angling Pressure	0	1	3	5
Dumping/Garbage/Trash/Litter	0	1	3	5
Exotic Plant Species	0	1	3	5
Fish Stocking	0	1	3	5
Hiking Trails	0	1	3	5
Campgrounds (Dispersed/Defined – circle)	0	1	3	5
Surface Films/Odors	0	1	3	5
Pesticide Application (Algaecide/Insecticide)	0	1	3	5
Waste From Pets (high concentration)	0	1	3	5
Other:	0	1	3	5

Habitat Modification				
Exotics Removal	0	1	3	5
Incised	0	1	3	5
Mass Wasting	0	1	3	5
Restoration	0	1	3	5
Other:	0	1	3	5

Natural Disturbance or Occurrence				
Waterfowl	0	1	3	5
Drought-related Impacts	0	1	3	5
Watershed Runoff Following Forest Fire	0	1	3	5
Recent Bankfull or Overbank Flows	0	1	3	5
Wildlife other than Waterfowl	0	1	3	5
Other Natural Sources:	0	1	3	5

Legend – Proximity Score			
Activity believed to be Absent	0	Activity observed or known to be present within 1 km of the channel	3
Activity believed to be present in Watershed	1	Activity observed or known to be present in the riparian zone	5

APPENDIX C

E.coli Data

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Table C.1 Rio Capulin *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Capulin above Cecilia Canyon Creek	29RCapul010.3	4/25/2007	1	-
		5/14/2007	4.1	14
		6/19/2007	261.3*	1.97
		7/11/2007	290.9*	1.1
		8/6/2007	260.3*	0.49
		9/17/2007	387.3*	0.34
		10/3/2007	56.5	0.34

Table C.2 Rio Chama (El Vado Reservoir to Rio Brazos) *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Chama below Rito de Tierra Amarilla above gage 08284100	29RChama147.0	4/3/2007	3	-
		5/15/2007	30.9	-
		7/12/2007	49.6	-
		8/7/2007	435.2*	-
		9/18/2007	1203.3*	67.12[a]
		10/2/2007	209.8	-
USGS 8284100	n/a	10/27/06	9	196
		04/25/07	2	984
		6/20/07	<16	223
		8/10/07	50	61
		6/30/08	180	442
		8/05/08	120	114

[a] flow measured on 9/4/2007

Table C.3 Rio Chama (Little Willow Creek to CO border) *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Chama at NM 17	29RChama183.4	4/3/2007	1	163.63
		4/3/2007	1	163.63
		5/15/2007	9.6	188.17
		5/15/2007	4.1	188.17
		6/20/2007	172.3	-
		7/12/2007	88	25.42
		8/7/2007	2419.6*	77.79
		9/18/2007	344.8*	30.41
		10/2/2007	13.4	47.67

Table C.4 Rio Chama (Rio Brazos to Little Willow Creek) *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Chama Below Chama Town	29RChama174.0	4/3/2007	1	211.62
		5/15/2007	13.2	-
		6/20/2007	38.4	161.57
		7/12/2007	185	29.62
		8/7/2007	2419.6*	90.97
		9/18/2007	372.5*	44.42
		10/2/2007	218.7	46.57

Table C.5 Rio Chamita (Rio Chama to CO border) *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Chamita at NM 29	29RChami008.3	4/3/2007	1	-
		5/15/2007	17.1	38.49
		6/20/2007	131.4	4.56
		7/12/2007	1203.3*	1.66
		8/7/2007	1119.9*	3.35
		9/18/2007	866.4*	2.37
		10/2/2007	31.3	1.07
Rio Chamita below Chama WWTP outfall	29RChami002.7	4/3/2007	8.6	42.93
		5/15/2007	55.6	54.56
		6/20/2007	81.6	0.85
		7/12/2007	2420*	0.93
		8/7/2007	2420*	19.18
		9/18/2007	547.5*	17.05
		10/2/2007	1119.9*	0.37

Table C.6 Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96) *E.coli* Data

Site	STORET	Date	E.coli data (cfu/100mL)	Flow (cfs)
Rio Puerco de Chama at CR 211	29RPuerc011.0	4/25/2007	285.1	22.32
		5/14/2007	172.3	51.63
		6/19/2007	39.1	4.16
		7/11/2007	137.6	0.48
		8/6/2007	1203.3*	3.72
		9/17/2007	2420*	4.26
		10/3/2007	365.4	3.38

APPENDIX D
HYDROLOGY, GEOMETRY, AND METEROLOGICAL INPUT DATA FOR SSTEMP

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LIST OF ACRONYMS

4Q3	Four-consecutive day discharge that has a recurrence interval of three years
cfs	Cubic Feet per Second
GIS	Geographic Information Systems
GPS	Global Positioning System
IOWDM	Input and Output for Watershed Data Management
mi^2	Square Miles
^oC	Degrees Celcius
SEE	Standard Error of Estimate
SSTEMP	Stream Segment Temperature
SWSTAT	Surface-Water Statistics
TMDL	Total Maximum Daily Load
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WinXSPRO	Windows-Based Stream Channel Cross-Section Analysis

D 1.0 INTRODUCTION

This appendix provides site-specific hydrology, geometry, and meteorological data for input into the Stream Segment Temperature (SSTEMP) Model (Bartholow 2002). Hydrology variables include segment inflow, inflow temperature, segment outflow, and accretion temperature. Geometry variables are latitude, segment length, upstream and downstream elevation, Width's A-term, Width's B-term, and Manning's n. Meteorological inputs to SSTEMP Model include air temperature, relative humidity, windspeed, ground temperature, thermal gradient, possible sun, dust coefficient, ground reflectivity, and solar radiation. In the following sections, these parameters are discussed in detail for each assessment unit to be modeled using SSTEMP Model. The assessment units were modeled on the day of the maximum recorded thermograph measurement. The assessment units and modeled dates are defined as follows:

Table D.1 Assessment Units and Modeled Dates

Assessment Unit ID	Assessment Unit Description	Modeled Date
NM-2116.A_030	Canjilon Creek (perennial portions Abiquiu Reservoir to headwaters	7/18/2010
NM-2116.A_000	Rio Chama (El Vado Reservoir to Rio Brazos)	8/3/2007
NM-2116.A_002	Rio Chama (Little Willow Creek to CO border)	8/5/2007
NM-2115_20	Rio Puerco de Chama (Abiquiu Reservoir to Hwy 96)	7/3/2007

D 2.0 HYDROLOGY

D2.1 Segment Inflow

This parameter is the *mean daily* flow at the top of the stream segment. If the segment begins at an effective headwater, the flow is entered into SSTEMP Model as zero. Flow data from USGS gages were used when available. To be conservative, the lowest four-consecutive-day discharge that has a recurrence interval of three years but that does not necessarily occur every three years (4Q3) was used as the inflow instead of the mean daily flow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. The 4Q3 will be determined for gaged sites using a log Pearson Type III distribution through "*Input and Output for Watershed Data Management*" (IOWDM) software, Version 4.1 (USGS 2002a) and "*Surface-Water Statistics*" (SWSTAT) software, Version 4.1 (USGS 2002b). The Rio Chama near La Puente, NM gage (08284100) is located in the Rio Chama (El Vado Reservoir to Rio Brazos) assessment unit. The calculated 4Q3 using gage date and DFLOW software is 17.6 cfs.

Discharges for ungaged sites on gaged streams were estimated based on methods published by Thomas *et al.* (1997). If the drainage area of the ungaged site is between 50 and 150 percent of the drainage area of the gaged site, the following equation is used:

$$Q_u = Q_g \left(\frac{A_u}{A_g} \right)^{0.5}$$

where,

Q_u = Area weighted 4Q3 at the ungaged site (cubic feet per second [cfs])
Q_g = 4Q3 at the gaged site (cfs)
A_u = Drainage area at the ungaged site (square miles [mi^2])
A_g = Drainage area at the gaged site (mi^2)

Drainage areas for assessment units to which this method was applied are summarized in the following table:

Table D.2 Drainage Areas for Estimating Flow by Drainage Area Ratios

Assessment Unit	USGS Gage	Drainage Area from Gage (mi^2)	Drainage Area from Top of AU (mi^2)	Drainage Area from Bottom of AU (mi^2)	Ratio of DA of Ungaged (upstream) to Gaged Site	Ratio of DA of Ungaged (downstream) to Gaged Site
NM-2116.A_030	(a)	--	— [(b)]	165.6	— [(b)]	-- [(b)]
NM-2116.A_000	08284100	480	390.8	482.1	**81.4%**	**100%**
NM-2116.A_002	08284100	480	53.16	102.2	11% [(c)]	21%[(c)]
NM-2115_20	(a)	--	92.57	202.3	—	--

Notes:
[(a)]Regression method developed by Waltemeyer (2002) was used to estimate flows since this is an ungaged stream.
[(b)] Assessment unit begins at headwaters.
[(c)] The method developed by Thomas et al. (1997) is not applicable because the drainage area of the ungaged site is less than 50 percent of the drainage area of the gaged site. Therefore, the method developed by Waltemeyer (2002) was used to estimate flows for this assessment unit.

mi^2 = Square miles
USGS = U.S. Geological Survey
AU = Assessment Unit

4Q3 derivations for ungaged streams were based on analysis methods described by Waltemeyer (2002). Two regression equations for estimating 4Q3 were developed based on physiographic regions of New Mexico (i.e., statewide and mountainous regions above 7,500 feet in elevation). The following statewide regression equation is based on data from 50 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 1.2856 \times 10^{-4} \; DA^{0.42} \; P_w^{\;3.16}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)

The average standard error of estimate (SEE) and coefficient of determination are 126 and 48 percent, respectively, for this regression equation (Waltemeyer 2002). The following regression equation for mountainous regions above 7,500 feet in elevation is based on data from 40 gaging stations with non-zero discharge (Waltemeyer 2002):

$$4Q3 \quad = \quad 7.3287 \times 10^{-5}\ DA^{0.70}\ P_w^{\ 3.58}\ S^{1.35}$$

where,

4Q3 = Four-day, three-year low-flow frequency (cfs)
DA = Drainage area (mi^2)
P_w = Average basin mean winter precipitation (inches)
S = Average basin slope (percent)

The average SEE and coefficient of determination are 94 and 66 percent, respectively, for this regression equation (Waltemeyer 2002). The drainage areas, average basin mean winter precipitation, and average basin slope for assessment units where this regression method was used are presented in the following table:

Table D.3 Parameters for Estimating Flow using USGS Regression Model

Assessment Unit	Regression Model[(a)]	Average Elevation for Assessment Unit (feet)	Mean Basin Winter Precipitation (inches)	Average Basin Slope (unitless)
NM-2116.A_030	(a)	7,877	9.38	13.7
NM-2116.A_000	n/a	9,488	18.0	18.6
NM-2116.A_002	(a)	9,813	21.83	25.4
NM-2115_20	(a)	8,067	10.46	17.3

Notes:
mi^2 = Square miles
n/a = not applicable
[(a)] Waltemeyer (2002)

Based on the methods described above, the following values were estimated for inflow:

Table D.4 Inflow

Assessment Unit	Ref.	4Q3 (cfs)	DAt (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Inflow (cfs)
NM-2116.A_030	n/a	–	–	–	9.38	13.7	0.00[(2)]
NM-2116.A_000	(a)	17.6 [(1)]	390.8	480	18.0	18.6	15.88
NM-2116.A_002	(b)	–	53.16	–	21.83	25.4	11.51
NM-2115_20	(b)	–	92.57	–	10.46	17.3	0.74

Notes:
N/A = Not applicable, assessment unit begins at headwaters.
Ref. = Reference
(a) Thomas et al. (1997)
(b) Waltemeyer (2002), mountainous

cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAt = Drainage area from top of segment
DAg = Drainage area from USGS gage
S = Average basin slope
(1) Based on period of record for USGS gage-Rio Chama near La Puente, NM (08284100)
(2) Inflow is zero because assessment unit begins at headwaters.

D2.2 Inflow Temperature

This parameter represents the *mean daily* water temperature at the top of the segment. 2007 data from thermographs positioned at the top of the assessment unit were used when possible. If the segment began at a true headwater, the temperature entered was zero degrees Celsius (°C) (zero flow has zero heat). The following inflow temperatures for impaired assessment units were modeled in SSTEMP:

Table D.5 Mean Daily Water Temperature

Assessment Unit	Upstream Thermograph Location	Inflow Temp. [1] (°C)	Inflow Temp. (°F)
NM-2116.A_030	None (headwaters)	0	32.0
NM-2116.A_000	Rio Chama below Chama Town [a]	17.62	63.72
NM-2116.A_002	Rio Chama at NM 17	15.39	59.70
NM-2115_20	Rio Puerco de Chama @ FR 103 [b]	11.50	52.70

Notes:
ºC = Degrees Celcius
ºF = Degrees Farenheit
[1] Mean daily average for 2007 water thermograph data
[a] thermograph from upstream Rio Chama AU- (Rio Brazos to Little Willow Creek)
[b] thermograph from Rio Pueco de Chama (Hwy 96 to headwaters) AU

D2.3 Segment Outflow

Flow data from USGS gages were used when available. To be conservative, the 4Q3 was used as the segment outflow. These critical low flows were used to decrease assimilative capacity of the stream to adsorb and disperse solar energy. Outflow was estimated using the methods described in Section D2.1. The following table summarizes 4Q3s used in the SSTEMP Model:

Table D.6 Segment Outflow

Assessment Unit	Ref.	4Q3 (cfs)	DAb (mi^2)	DAg (mi^2)	Pw (in)	S unitless	Outflow (cfs)
NM-2116.A_030	(b)	–	165.6	–	9.38	13.7	0.54
NM-2116.A_000	(a)	17.6 (1)	482.1	480	18.0	18.6	17.64
NM-2116.A_002	(b)	–	102.2	–	21.83	25.4	18.17
NM-2115_20	(b)	–	202.3	–	10.46	17.3	1.28

Notes:
Ref. = Reference
(a) Thomas et al. (1997)
(b) Waltemeyer (2002), mountainous
cfs = cubic feet per second
mi^2 = Square miles
in = Inches
Pw = Mean winter precipitation
DAb = Drainage area from bottom of segment
DAg = Drainage area from USGS gage
S = Average basin slope
(1) Based on period of record for USGS gage-Rio Chama near La Puente, NM (08284100)

D2.4 Accretion Temperature

The temperature of the lateral inflow, barring tributaries, generally should be the same as groundwater temperature. In turn, groundwater temperature may be approximated by the mean annual air temperature. Mean annual air temperatures for 2007 and 2010 were used in the absence of measured annual data. The following table presents the mean annual air temperature for each assessment unit:

Table D.7 Mean Annual Air Temperature as an Estimate for Accretion Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (°C)	Mean Annual Air Temperature (°F)
NM-2116.A_030	(a)[1]	4.51	40.121
NM-2116.A_000	(b)	5.55	41.989
NM-2116.A_002	(b)	5.55	41.989
NM-2115_20	(b)	5.55	41.989

Notes:
Ref. = References for Weather Station Data are as follows:
(a) *New Mexico State University Climate Network (NRCS Snotel Weather Station, Latitude 36.95 N, Longitude 106.65 W),* ***2010***
note: data available at the time of TMDL development was Jan 1-Nov 30
(b) *New Mexico State University Climate Network (NRCS Snotel Weather Station, Latitude 36.95 N, Longitude 106.65 W),* ***2007***
1 *note: data available at the time of TMDL development was Jan 1-Nov 30. Value will be recalculated when data through December 31 is available.*

ºF = Degrees Farenheit
ºC = Degrees Celcius

D 3.0 GEOMETRY

D3.1 Latitude

Latitude refers to the position of the stream segment on the earth's surface. Latitude is generally determined in the field with a global positioning system (GPS) unit. Latitude for each assessment unit is summarized below:

Table D.8 Assessment Unit Latitude

Assessment Unit	Latitude (decimal degrees)
NM-2116.A_030	36.29
NM-2116.A_000	36.66
NM-2116.A_002	36.89
NM-2115_20	36.26

D3.2 Dam at Head of Segment

The following assessment units have a dam at the upstream end of the segment with a constant, or nearly constant diel release temperature:

Table D.9 Presence of Dam at Head of Segment

Assessment Unit	Dam?
NM-2116.A_030	No
NM-2116.A_000	Yes
NM-2116.A_002	No
NM-2115_20	No

D3.3 Segment Length

Segment length was determined with National Hydrographic Dataset Reach Indexing GIS tool. The segment lengths are as follows:

Table D.10 Segment Length

Assessment Unit	Length (miles)
NM-2116.A_030	30.63
NM-2116.A_000	14.95
NM-2116.A_002	9.92
NM-2115_20	8.81

D3.4 Upstream Elevation

The following upstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.11 Upstream Elevations

Assessment Unit	Upstream Elevation (feet)
NM-2116.A_030	10,420
NM-2116.A_000	7,300
NM-2116.A_002	8,460
NM-2115_20	6,678

D3.5 Downstream Elevation

The following downstream elevations were determined with National Hydrographic Dataset Reach Indexing GIS tool.

Table D.12 Downstream Elevations

Assessment Unit	Downstream Elevation (feet)
NM-2116.A_030	6,200
NM-2116.A_000	6,920
NM-2116.A_002	7,800
NM-2115_20	6,175

D3.6 Width's A and Width's B Term

Width's B Term was calculated as the slope of the regression of the natural log of width and the natural log of flow. Width-versus-flow regression analyses were prepared by entering cross-section field data into a Windows-Based Stream Channel Cross-Section Analysis (WINXSPRO 3.0) Program (U.S. Department of Agriculture [USDA] 2005). Theoretically, the Width's A Term is the untransformed Y-intercept. However, because the width versus discharge relationship tends to break down at very low flows, the Width's B-Term was first calculated as the slope and Width's A-Term was estimated by solving for the following equation:

$$W = A \times Q^B$$

where,

W = Known width (feet)
A = Width's A-Term (seconds per square foot)
Q = Known discharge (cfs)
B = Width's B-Term (unitless)

The following table summarizes Width's A- and B-Terms for assessment units requiring temperature TMDLs:

Table D.13 Width's A and Width's B Terms

Assessment Unit	Width's B-Term	Width's A-Term
NM-2116.A_030	0.352	51.0
NM-2116.A_000	0.194	31.3
NM-2116.A_002	0.322	13.2
NM-2115_20	0.140	16.5

The following figures present the detailed calculations for the Width's B-Term.

Measurements were collected at one site within these assessment units. The regression of natural log of width and natural log of flow for each location is as follows:

Figure D.1 Wetted Width versus Flow for Assessment Unit NM-2116.A_030

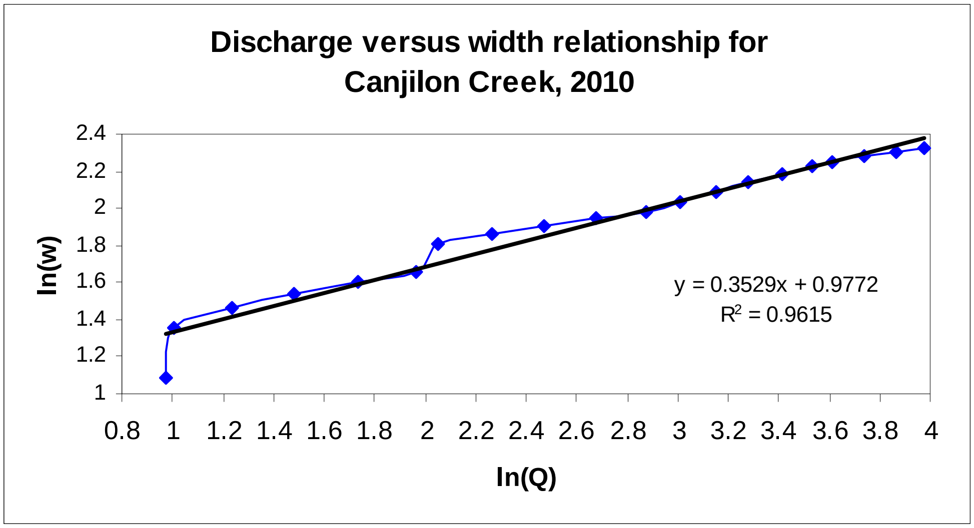


Figure D.2 Wetted Width versus Flow for Assessment Unit NM-2116.A_000

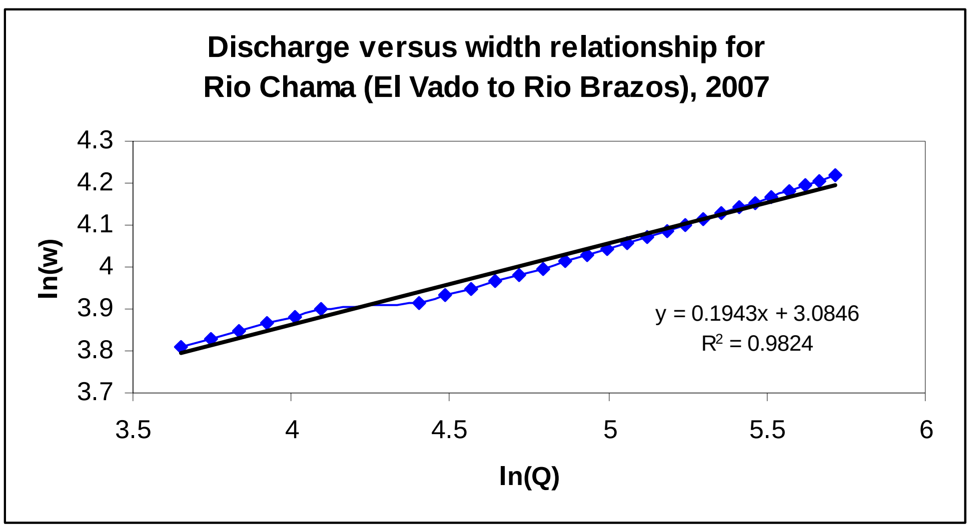


Figure D.3 Wetted Width versus Flow for Assessment Unit NM-2116.A_002

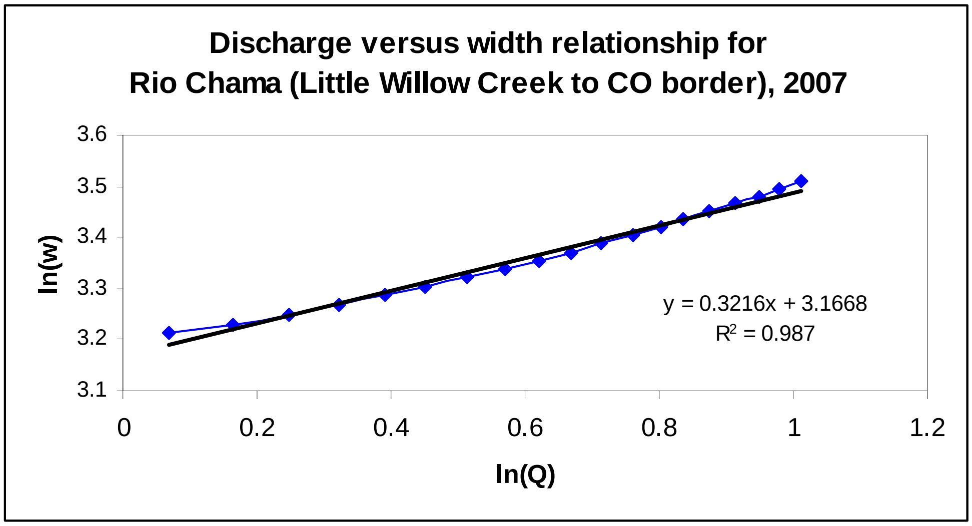
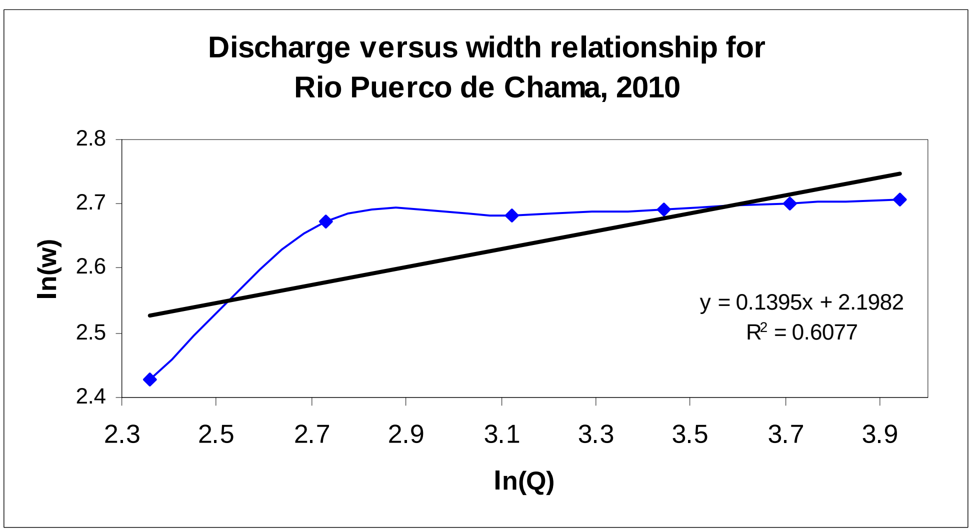


Figure D.4 Wetted Width versus Flow for Assessment Unit NM-2115_20



D3.7 Manning's n or Travel Time

Site-specific values were calculated using Strickler's equation to estimate Manning's roughness based on prevailing sediment sizes in the streambed:

$$n = \frac{(d_{50})^{1/6}}{21.0}$$

where d_{50} is the median sediment size in meters.

The following table summarizes the Manning’s n input values for each assessment unit:

Table D.14 Manning’s n values

Assessment Unit	d_{50} (in meters)	Manning’s n
NM-2116.A_030	32	0.085
NM-2116.A_000	54	0.093
NM-2116.A_002	46	0.090
NM-2115_20	0.38	0.041

D 4.0 METEOROLOGICAL PARAMETERS

D4.1 Air Temperature

This parameter is the mean daily air temperature for the assessment unit (or average daily temperature at the mean elevation of the assessment unit). Air temperature will usually be the single most important factor in determining mean daily water temperature. Air temperatures are usually measured directly (in the shade) using air thermographs and adjusted to what the temperature would be at the mean elevation of the assessment unit. The following table summarizes mean daily air temperatures for each assessment unit (for its modeled date) requiring a temperature TMDL:

Table D.15 Mean Daily Air Temperature

Assessment Unit	Elevation at Air Thermograph Location (meters)	Measured Mean Daily Air Temperature (°C)	Mean Elevation for Assessment Unit (meters)	Adjusted Mean Daily Air Temperature (°C)	Adjusted Mean Daily Air Temperature (°F)
NM-2116.A_030	1932 [a]	24.72	2401	21.64	70.95
NM-2116.A_000	2418 [b]	17.01	2892	13.90	57.02
NM-2116.A_002	2418 [b]	17.50	2991	13.74	56.73
NM-2115_20	2418 [b]	20.87	2459	20.60	69.08

Notes:

ºF = Degrees Farenheit
ºC = Degrees Celcius
[a] *No air thermograph deployed in 2010. Highest water temperature recorded in 2007 occurred on July 1. Air thermograph data from 29Canjil006.2 on July 1, 2007 will be used.*
[b] *No air thermographs deployed. Air thermograph at Rio Gallina @ FR 76 was used.*

The adiabatic lapse rate was used to correct for elevational differences from the met station:

$$T_a \quad = \quad T_o + C_t \times \left(Z - Z_o\right)$$

where,

T_a = air temperature at elevation E (°C)
T_o = air temperature at elevation E_o (°C)
Z = mean elevation of segment (meters)
Z_o = elevation of station (meters)
C_t = moist-air adiabatic lapse rate (-0.00656 °C/meter)

D4.2 Maximum Air Temperature

Unlike the other variables, the maximum daily air temperature overrides only if the check box is checked. If the box is not checked, the SSTEMP Model estimates the maximum daily air temperature from a set of empirical coefficients (Theurer et al., 1984 as cited in Bartholow 2002) and will print the result in the grayed data entry box. A value cannot be entered unless the box is checked.

D4.3 Relative Humidity

Relative humidity data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The data were corrected for elevation and temperature using the following equation:

$$R_h = R_o \times \left(1.0640^{(To-Ta)}\right) \times \left(\frac{T_a + 273.16}{T_o + 273.16}\right)$$

where,

R_h = relative humidity for temperature T_a (decimal)
R_o = relative humidity at station (decimal)
T_a = air temperature at segment (°C)
T_o = air temperature at station (°C)

The following table presents the adjusted mean daily relative humidity for each assessment unit:

Table D.16 Mean Daily Relative Humidity

Assessment Unit	Ref.	Mean Daily Air Temp. at Weather Station (°C)	Mean Daily Air Temperature at AU (°C)	Mean Daily Relative Humidity at Weather Station (percent)	Mean Daily Relative Humidity for AU (percent)
NM-2116.A_030	(a)	23.73	21.64	47.50	53.69
NM-2116.A_000	(b)	17.20	13.90	57.10	69.28
NM-2116.A_002	(a)	16.30	13.74	64.12	74.50
NM-2115_20	(a)	18.70	20.60	41.38	37.02

Notes:
Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Stone Lake RAWS, Latitude 36.731400 N, Longitude 106.864700 W),* ***modeled dates in 2010***
(b) *New Mexico State University Climate Network (NRCS Snotel Weather Station, Latitude 36.95 N, Longitude 106.65 W),* ***2007***

AU = Assessment Unit
°C = Degrees Celsius

D4.4 Wind Speed

Average daily wind speed data were obtained from the New Mexico State University Climate Network (http://weather.nmsu.edu/data/data.htm). The following table presents the mean daily wind speed for each assessment unit:

Table D.17 Mean Daily Wind Speed

Assessment Unit	Ref.	Mean Daily Wind Speed (miles per hour)	Date
NM-2116.A_030	(a)	4.542	7/18/2010
NM-2116.A_000	(b)	4.250	8/3/2007
NM-2116.A_002	(b)	2.727	8/5/2007
NM-2115_20	(b)	4.304	7/3/2007

Notes:
Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Stone Lake RAWS, Latitude 36.731400 N, Longitude 106.864700 W)*
(b) *New Mexico State University Climate Network (Taos Portable #1RAWS, Latitude 36.872500 N, Longitude 105.988056 W)*

D4.5 Ground Temperature

Mean annual air temperature data for 2007 and 2010 were used in the absence of measured data. The following table presents the mean annual air temperature for each assessment unit:

Table D.18 Mean Annual Air Temperature as an Estimate for Ground Temperature

Assessment Unit	Ref.	Mean Annual Air Temperature (^{o}C)	Mean Annual Air Temperature (^{o}F)
NM-2116.A_030	(a) [1]	4.51	40.121
NM-2116.A_000	(a)	5.55	41.989
NM-2116.A_002	(a)	5.55	41.989
NM-2115_20	(a)	5.55	41.989

Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Hopewell NRCS Snotel Weather Station, Latitude 36.95 N, Longitude 106.65 W),* ***2010***
note: data available at the time of TMDL development was Jan 1-Nov 30
(b) *New Mexico State University Climate Network (Hopewell NRCS Snotel Weather Station, Latitude 36.95 N, Longitude 106.65 W),* ***2007***
1 *note: data available at the time of TMDL development was Jan 1-Nov 30. Value will be recalculated when data through December 31 is available.*

ºF = Degrees Farenheit
ºC = Degrees Celcius

D4.6 Thermal Gradient

The default value of 1.65 was used in the absence of measured data.

D4.7 Possible Sun

Percent possible sun for Albuquerque is found at the Western Regional Climate Center web site http://www.wrcc.dri.edu/htmlfiles/westcomp.sun.html#NEW%20MEXICO. The percent possible sun is 77 for July and 73 for August for the Clayton station.

D4.8 Dust Coefficient

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section D4.10).

D4.9 Ground Reflectivity

If a value is entered for solar radiation, SSTEMP Model will ignore the dust coefficient and ground reflectivity and "override' the internal calculation of solar radiation. Solar radiation data are available from the New Mexico State University Climate Network (see Section D4.10).

D4.10 Solar Radiation

Because solar radiation data were obtained from an external source of ground level radiation, it was assumed that about 90% of the ground-level solar radiation actually enters the water. Thus, the recorded solar measurements were multiplied by 0.90 to get the number to be entered into the SSTEMP Model. Few stations in north-central New Mexico had available solar radiation data for 2007 or the following years until 2010. In lieu of recorded data for 2007, the following table presents the measured solar radiation for 2010:

Table D.19 Mean Daily Solar Radiation

Assessment Unit	Ref.	Date	Mean Solar Radiation (L/day)	Mean Solar Radiation x 0.90 (L/day)
NM-2116.A_030	(a)	7/18/2010	617.59	555.83
NM-2116.A_000	(a)	8/3/2010	585.07	526.56
NM-2116.A_002	(a)	8/5/2010	471.94	424.74
NM-2115_20	(a)	7/3/2010	669.05	602.14

Ref. = References for Weather Station Data are as follows:

(a) *New Mexico State University Climate Network (Stone Lake RAWS, Latitude 36.731400 N, Longitude 106.864700 W)*

D 5.0 SHADE

Percent shade was estimated for the assessment units using field estimations per geomorphological survey field notes from 2007 and 2010. The value in Table D.20 reflects the average of 6 measurements taken each at 11 cross-sections at the primary site in the AU in 2007 and 6 measurements at each of 5 cross-sections in 2010. The measurements may have also been averaged along with visual estimates using USGS digital orthophoto quarter quadrangles downloaded from New Mexico Resource Geographic Information System Program (RGIS), online at http://rgis.unm.edu/. This parameter refers to how much of the segment is shaded by vegetation, cliffs, etc. The following table summarizes percent shade for each assessment unit:

Table D.20 Percent Shade

Assessment Unit	Site	Date	Percent Shade
NM-2116.A_030	29Canjil039.5	8/30/2010	54%
NM-2116.A_000	29RChama143.8	9/4/2007	9.5%
NM-2116.A_002	29RChama183.4	9/5/2007	33%
NM-2115_20	29RPuerc011.0	8/30/2010	10%*

**Field staff note on 8/30/2010 that aerial photographs should be checked to see if this site (with fencing across the upstream portion) is representative of the AU. Field staff note 65% shade and aerial photographs were used to modify this field measurement to represent the entire AU.*

D 6.0 REFERENCES

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APPENDIX E
PUBLIC PARTICIPATION FLOWCHART

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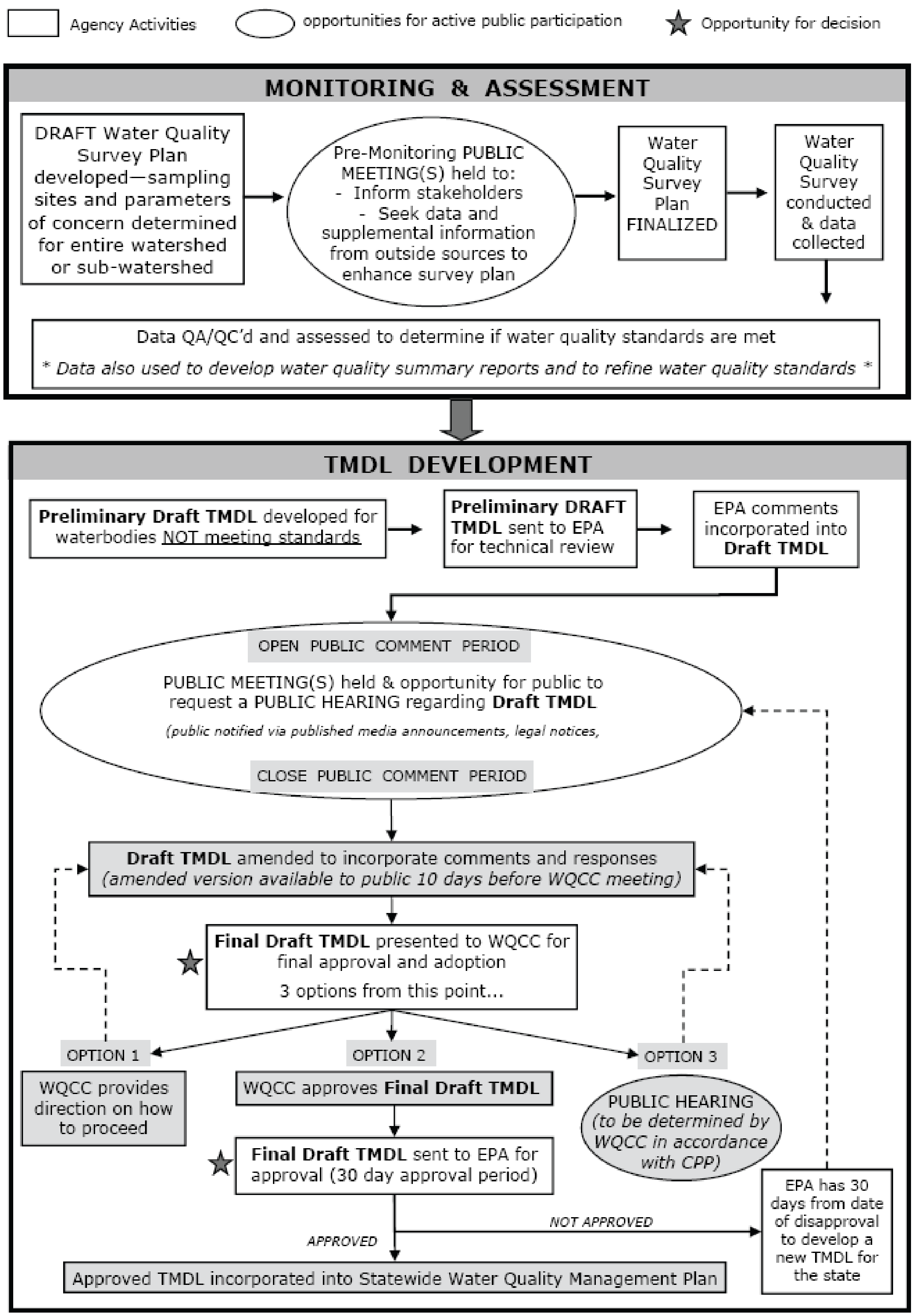
Monitoring, Assessment, & TMDL Development Process



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APPENDIX F
RESPONSE TO COMMENTS

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SWQB hosted a public meeting in Tierra Amarilla NM on March 7, 2011 to discuss the Public Comment Draft Rio Chama Watershed TMDL. Notes from the public meeting are available in the SWQB Administrative Record. The following changes were made to the Final Draft document in response to staff comments either during or after the public comment period:

1. Based on staff comment, the TMDL allocations for temperature on Rio Chama (Little Willow Creek to CO border) were corrected in the Executive Summary table. Likewise, the Load Allocation for *E.coli* for Rio Chama (Little Willow Creek to CO border) was corrected in both the Executive Summary table and Table 3.7.
2. Available nutrient data for Los Ojos Fish Hatchery was added to Sections 4.4.1 and 8.1.

Written comments received during the 30-day public comment period:

A. Jose B. Archuleta, Los Ojos water association
B. James A. Heath, owner of Dos Rios Ranch, LLC in Chama
C. Village of Chama
D. Greg Friday, Chama resident

Comment Set A:

Surface Water Quality Bureau
NEW MEXICO ENVIRONMENT DEPARTMENT

Public Comment Card

Meeting Date: 3-8-2011

Comments Regarding: Softy of water that are Drink

*OPTIONAL INFORMATION :

*Name: Jose B Archuleta *Affiliation: Los Ojos water assn.

*E-Mail:

*Mailing Address: Box 154 Los Ojos New Mexico 87551

Comments must be submitted in writing in order to be included in the public record. Please provide comments in the space below (use back if necessary):

1 Need more mony up North –
2 to Fix swar syten –
3 cement plants.
4 Fertzer of on fields –

Turn comment card in tonight or mail / fax:

TMDL Coordinator 5469
Surface Water Quality Bureau, P. O. Box ~~26110,~~ Santa Fe, NM 87502
Phone: (505) 827-0187; Fax: (505) 827-0160

<u>SWQB Response:</u> *Thank you for your comments and your attendance at the public meeting on March 7, 2011. SWQB recognizes your concern about the safety of drinking water and the need for funding to improve potential sources of water quality impairment; specifically sewer systems, cement plants, and fertilizer on fields.*

The drinking water intake for the Village of Chama is from the Rio Chama above the Village and is not impacted by the WWTP discharge. Residents downstream of the WWTP outfall may have private drinking water wells at varying depths. NMED-Drinking Water Quality Bureau recommends that these residents use disinfection and have their well water tested. More information can be found online at: http://www.nmenv.state.nm.us/dwb/index.htm. Historically, the water source for the Village of Los Ojos has been from an infiltration gallery from the Rio Chama, but a new water treatment plant was recently constructed and a new high producing well installed.

SWQB encourages you to contact NMED-Construction Programs Bureau regarding funding for water and wastewater infrastructure assistance http://www.nmenv.state.nm.us/cpb/cpbtop.html and the Watershed Protection Section within SWQB for funding assistance for watershed improvement projects. http://www.nmenv.state.nm.us/swqb/WPS/. Funding options are also discussed in Section 8.0 of the Rio Chama TMDL.

Comment Set B:

James A. Heath
438 San Pasqual
Santa Fe, NM 87505

Ms. Heidi Henderson
NMED SWQB
P.O. Box 5469
Santa Fe, NM 87502

Dear Ms. Henderson,

I am writing this letter as the owner of the Dos Rios Ranch, LLC in Chama, New Mexico for the purpose of providing comment on the draft "total maximum daily load" (TMDL) document for the Rio Chama Watershed. My comments are specific to the Chamita River, which flows through my ranch until it converges with the Chama River on the ranch itself. I am aware that the Chamita River, running south from the water treatment facility for the Villageof Chama (located just to the north of my property) is discharging significant excess pollutants into the Chamita as it flows through the ranch. It is known that these pollutants are far in excess of those allowed under the National Pollution Discharge Effluent Standard (NPDES) allowed under the U.S. Clean Water Act.

I earnestly request that the appropriate authorities cause this violation to be rectified, as soon as possible, for human health and safety, as well as the health and safety of all plant, animal and fish in and around that portion of the Chamita River.

Sincerely,

Jim Heath

James A. Heath

cc Jim Karp, New Mexico Game and Fish Dept.
Greg Friday
cc.

SWQB Response: *Thank you for your comments. SWQB understands that the Village of Chama WWTP (NPDES Permit Number NM0027731) exceeds the NPDES permit limits for BOD, pH, TSS, E. coli, aluminum, and ammonia. Those exceedences contribute to the water quality impairments of both the high quality coldwater aquatic life and secondary contact designated uses as documented by SWQB in the New Mexico 303d list of impaired waters (http://www.nmenv.state.nm.us/swqb/303d-305b/2010-2012/).*

EPA Region 6 is the NPDES permitting and enforcement authority for New Mexico. The Village of Chama WWTP received an Administrative Order from EPA Region 6 for effluent violations in both December 2004 and November 2007. In 2007, SWQB did not support the Village's request for funding to expand the sewer collection system specifically because of the continued noncompliance with the existing NPDES permit. SWQB recognizes the ongoing water quality concerns in the Rio Chamita. Following the March 7, 2011 public meeting, SWQB management met with the Division Director of the Compliance, Assurance, and Enforcement Division of EPA Region 6 and discussed the history of noncompliance of the WWTP. The comments and concerns expressed at the public meeting were also relayed to Enforcement Division management at this meeting.

The Village has made repairs to its collection system and, as of March 2011, has a Preliminary Engineering Review with design options for a WWTP that will improve effluent water quality and will have the treatment ability to remove the nutrients, total nitrogen and total phosphorous. At this time the Village is seeking funding to build and operate the new WWTP. SWQB will continue to stay in contact with the Village and EPA Region 6 during the further design and construction of a WWTP.

Comment Set C:

March 25, 2011

Ms. Heidi Henderson
TMDL Coordinator
New Mexico Environment Department
1190 St. Francis Drive, P.O. Box 5469
Santa Fe, NM 87502

RE: Public Comment Draft – TMDL for the Rio Chama Watershed

Dear Ms. Henderson:

First, we would like to thank you and the other staff from the New Mexico Environment Department (NMED) for meeting with us on Wednesday, March 23, 2011 to review and discuss the contents of the Public Comment Draft Total Maximum Daily Load (TMDL) study completed for the Rio Chama Watershed. This letter is intended to convey the Village's comments on this Report.

The Village of Chama's existing wastewater treatment plant (WWTP) is a lagoon system that is now more than 30 years old. The Village recognizes the need to improve the condition of the WWTP to produce a better quality effluent prior to discharge into the Rio Chamita. However, the existing facility cannot be retrofitted for plant nutrient removal. The findings in the draft TMDL for effluent nutrient limits will require the Village to transition from a very basic treatment system to a highly sophisticated WWTP.

The new facility will need both biological and chemical nutrient removal systems. The new WWTP will also require the installation of sludge treatment processes as the current facility does not have any equipment or facilities for sludge treatment. The Village of Chama is very concerned about the economic impact to our residents associated with constructing and operating a sophisticated WWTP as is required to achieve the nutrient limits proposed in the draft TMDL. The Village hopes that the financial implications for the residents of Chama are taken into consideration when finalizing this TMDL and when the Environmental Protection Agency (EPA) drafts the new National Pollution Discharge Elimination System (NPDES) permit for the WWTP.

Below are some comments related to the contents of the TMDL:

1) <u>Section 4.4.1 Waste Load Allocation, Page 42, Paragraph 3</u>

The Village recommends that the first sentence be modified as follows: "After implementation of **<u>the Phase 1</u>** effluent limits based on this TMDL and given enough time to allow the aquatic ~~to~~ system to respond, NMED will reevaluate the conditions in the Rio Chama and Rio Chamita."

2) <u>Section 8.1 Point Sources – NPDES Permitting, Seasonal Option</u>

Given the very cold temperatures in Chama year round, practical seasonal effluent limits have a great potential to provide some relief to the Village, in particular during the winter. The effect of low temperatures in biological treatment systems is acknowledged on several occasions in the TMDL (i.e. pages 42, 43, and 81).

(575) 756-2184 • FAX (575) 756-2412 • 299 4th Street • P.O. Box 794 • Chama, New Mexico 87520

The limits as proposed in Section 8.1 (specifically the April 1 to September 30 Total Nitrogen limit of 3.0 mg/L and Total Phosphorus of 0.1 mg/L) will result in a more costly WWTP because in Chama it is still quite cold in April. Furthermore, the proposed seasonal limit for the period from April 1 to September 30 of 3.0 mg/L TN and 0.1 TP mg/L are right at the edge of the limits of current technologies. In order to consistently achieve those limits, the sophistication of the WWTP may be even higher than the required for the Phase 1 limits.

It does not seem reasonable that winter discharges, which occur when the river ecosystem is essentially in hibernation, should affect the spring, summer, and fall discharges. As such, and given the information presented in Section 4.4.1 for Phase 1, the Village proposes the following seasonal limits:

- October 1 through April 30: TP = 1.0 mg/L, TN = 10 mg/L
- May 1 through September 30: TP = 0.4 mg/L, TN = 4.0 mg/L

These limits provide a better potential for the Village to consistently be in compliance with the NPDES discharge permit without adversely affecting the environment. The proposed change in the seasonal limit for the "warm" season is the same concentration of 4.0 mg/L TN and 0.4 mg/L TP included in the TMDL for the Phase 1 year-round alternative. We believe that the proposed change in the limits for the seasonal alternative will greatly help towards the efforts of improving the Rio Chama watershed, while at the same time may help reduce the costs associated with constructing and operating a new WWTP.

The Village of Chama and its residents are very reliant on the natural setting and environment in and around the community, particularly the Rio Chama watershed. The Village wishes to do their part in improving the watershed and maintaining a high level of water quality for its benefit to the area as well as those downstream. However, the results of this TMDL study will cause a significant economic impact to the Village residents and businesses. We request that the economic feasibility of adopting the effluent limits in this document be considered when finalizing the TMDL for the Rio Chama Watershed.

If you have any questions, please feel free to contact me at (575) 756-2184.

Sincerely,

VILLAGE OF CHAMA

Archie J Vigil

Mayor Archie Vigil

cc: Mr. Darren DeYapp, Councilor, Village of Chama
Ms. Barbara Cooney, NMED, Surface Water Quality Bureau
Mr. Clayton Ten Eyck, P.E., Molzen Corbin

SWQB Response: *Thank you for your comments. SWQB also appreciates the opportunity to meet with Village and Molzen-Corbin staff on March 23, 2011 to discuss questions regarding the TMDL and updates about the new WWTP.*

While SWQB understands the increased financial costs of a new WWTP on the Village and its residents, Section 303(d)(1)(C) of the Federal Clean Water Act requires states to develop TMDL management plans for water bodies determined to be water quality limited. The Rio Chamita was identified as impaired prior to the 1998 State of New Mexico §303(d)/ §305(b) Integrated List. TMDLs were written in 1999 and 2004 to address water quality impairments in the Rio Chamita. The Village of Chama WWTP received an Administrative Order from EPA Region 6 for effluent violations in both December 2004 and November 2007. Water quality impairments persist in the Rio Chamita but SWQB is optimistic that the recent Preliminary Engineering Review process and discussions with NMED-Construction Programs Bureau (CPB) will lead to improved treatment of the Village's wastewater as well as improved water quality in the Rio Chamita.

In the EPA document, Guidance for Water Quality-based Decisions: The TMDL Process (Second Edition), it is suggested that States discuss the economic impact of TMDLs with permittees during the Implementation stage of TMDL development-

> *"Point source facilities generally have mechanisms in place to secure funds needed for implementing the retrofits, process modifications, and additional pollutant controls that may be required to meet the load allocations required within a TMDL. Whether they are affected individually or as part of a category of sources, facilities should be consulted about how to best fund required actions. EPA anticipates that the economic feasibility of various allocation strategies will be discussed at this stage of TMDL establishment."*

SWQB and CPB staff have met on numerous occasions with the Village regarding the new WWTP and continue to be available to discuss funding opportunities. Development of the TMDL included balancing both the limits of treatment technology as well as the need to improve water quality, but the ultimate decision about established effluent limits will be by EPA Region 6 during the permit development process.

SWQB acknowledges that the wasteload allocations (WLAs) established in the TMDL for the point source pollution from the Chama WWTP will require changes and improvements to the design and operation of the facility. SWQB also appreciates the Village's commitment to maintain a high level of water quality to improve the watershed. The following are SWQB's responses to the Village's specific comments related to the contents of the TMDL:

1. *The first sentence in Section 4.4.1, page 42, Paragraph 3 was modified in the TMDL based on the Village's recommendations.*

2. *SWQB has established general growing season definitions for other applications, such as determining critical flows and analysis of nutrient dynamics in lakes. Growing seasons were established for three regions by using the median annual dates of the last and first frost from the National Weather Service (Table F.1). The elevation of the stream at the*

discharge point is less than 7100 feet corresponding to a growing season beginning in June, on average.

Table F.1. Growing season definitions for ecoregion and elevation classes

Regions	*Ecoregion Names*	*Begin*	*End*	*Length*
Mountain >7500 ft	*S. Rockies & AZ/NM Mountains*	*1-July*	*1-Oct*	*3 months*
Mountains <7500 ft & Plateau	*S. Rockies, AZ/NM Mountains & AZ/NM Plateau*	*15-Jun*	*1-Nov*	*4 ½ months*
S. Deserts and Plains	*SW Tablelands & Chihuahuan Desert*	*15-May*	*15-Nov*	*6 months*

After reviewing these definitions, it is reasonable from a biological perspective to begin the "warm" season on May 1. This should provide some relief to the Village especially during the colder months when low temperatures reduce the effectiveness of biological treatment systems. A May start date should also provide a buffer for the stream before temperatures and daylight hours increase to their annual maximums. In other words, the stream will not experience intense nutrient loading just prior to the growing season thus lowering the potential for nuisance algae growth. The Village's recommendations were added to Section 8.1 of the TMDL with an additional note regarding this comment. In addition, the "warm" season effluent limits were modified to correspond to the Phase 1 effluent limits defined in the TMDL (TP: 0.4 mg/L, TN: 4.0 mg/L).

SWQB changed the TMDL document to reflect the one request in Comment 1 and the two requests in Comment 2, however, the Village should be aware that this language is provided in the implementation section which EPA does not review when they consider approval of this TMDL because it considered "guidance" for achieving the goals of the TMDL. As such, the final determination of permit language and seasonality will be up to EPA Region 6 and through our state certification process (http://www.nmenv.state.nm.us/swqb/wqa/) NMED NPDES staff.

Comment Set D:

Greg Friday
4650 Danielle Drive
Chama, NM 87520

Ms. Heidi Henderson
NMED SWQB
P.O. Box 5469
Santa Fe, NM 87502

March 28, 2011

Dear Ms. Henderson,

My concern regarding the Rio Chama Watershed is the continued non-compliance of the Chama WWTP. These illegal discharges into the Rio Chamita have adversely affected the health of the Riparian and Fisheries habitats for years. Not to mention the potential health issues to down -stream users.
I am well aware of the funding issues involved in the construction of a new WWTP. But this does not absolve the Village of Chama or the State of New Mexico from complying with or enforcing the EPA standards in regards to The Clean Water Act.
Until such time that these funding issues can be resolved I think it's irresponsible for the Village of Chama to continue allowing new septic hook ups to the already over-taxed system. In addition to the non compliant discharges the un-regulated diversion of irrigation water adds to the pollutant concentrations in this river.
Should you or your staff need access to the private land portion of the Chamita below the WWTP please call.

Sincerely,
Greg Friday
575-756-8301

<u>SWQB Response:</u> *Thank you for your comments and your attendance at the public meeting on March 7, 2011.*

EPA Region 6 is the NPDES permitting and enforcement authority for New Mexico. SWQB recognizes the ongoing water quality concerns in the Rio Chamita. In 2007, SWQB did not support the Village's request for funding to expand the sewer collection system specifically because of the continued noncompliance with the existing NPDES permit. Following the public meeting, SWQB management met with the Division Director of the Compliance, Assurance, and Enforcement Division of EPA Region 6 and discussed the history of noncompliance of the WWTP. The comments and concerns expressed at the public meeting were also relayed to Enforcement Division management at this meeting.

The Probable Source "flow alterations from water diversions" is currently listed for the Rio Chama (Rio Brazos to Little Willow Creek) and Rio Chamita (Rio Chama to CO border). While SWQB understands that water quantity can adversely affect water quality, SWQB has no authority over irrigation diversions. The Clean Water Act and the New Mexico Water Quality Act contain limitations regarding the impact of water quality decisions on water rights as follows:

> *CWA 33 U.S.C. §1251 (g): "It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is further the policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources."*
>
> *NMSA 1978 §74-6-12.A (1999): "The Water Quality Act does not grant to the commission or to any other entity the power to take away or modify the property rights in water, nor is it the intention of the Water Quality Act to take away or modify such rights."*

SWQB often coordinates with landowners and appreciates the offer for your assistance regarding river access. SWQB will be conducting a water quality survey in the Rio Chama watershed in 2012.